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Chang et al.

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(54) **BACKLIGHT MODULE WITH LIGHT GUIDE PLATE HAVING OPTICALLY SEPARATED LIGHT GUIDE BODY**

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F21V 7/04 (2006.01)
F21V 8/00 (2006.01)

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CPC ***G02B 6/0068*** (2013.01); *G02B 6/0038* (2013.01); *G02B 6/0078* (2013.01)
USPC **362/616**; 362/628; 362/23.1; 349/65; 385/129

(58) **Field of Classification Search**
USPC 362/23.1, 23.17, 616, 620, 628, 511; 349/65; 385/129
See application file for complete search history.

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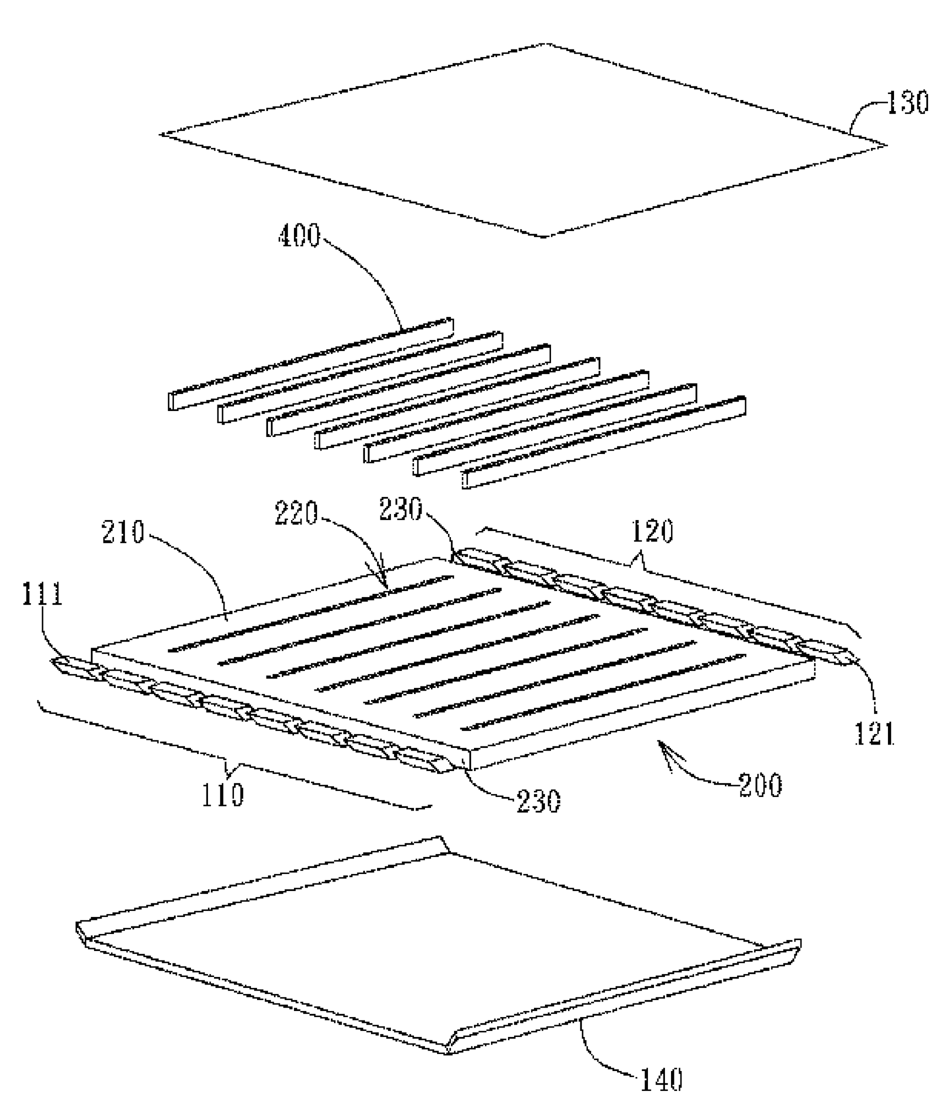
(57) **ABSTRACT**

The light guide plate includes a light guide plate body and a first medium, wherein the refractive index of the light guide plate body is greater than the refractive index of the first medium. The light guide plate body includes a plurality of gaps parallel with each other, wherein the first medium is disposed in those gaps. The light guide plate body further includes a light entrance end, wherein the gaps extend in directions both away and toward the light entrance end. Furthermore, an active region is defined on the light guide plate body and the gaps are located in the active region.

27 Claims, 15 Drawing Sheets

100



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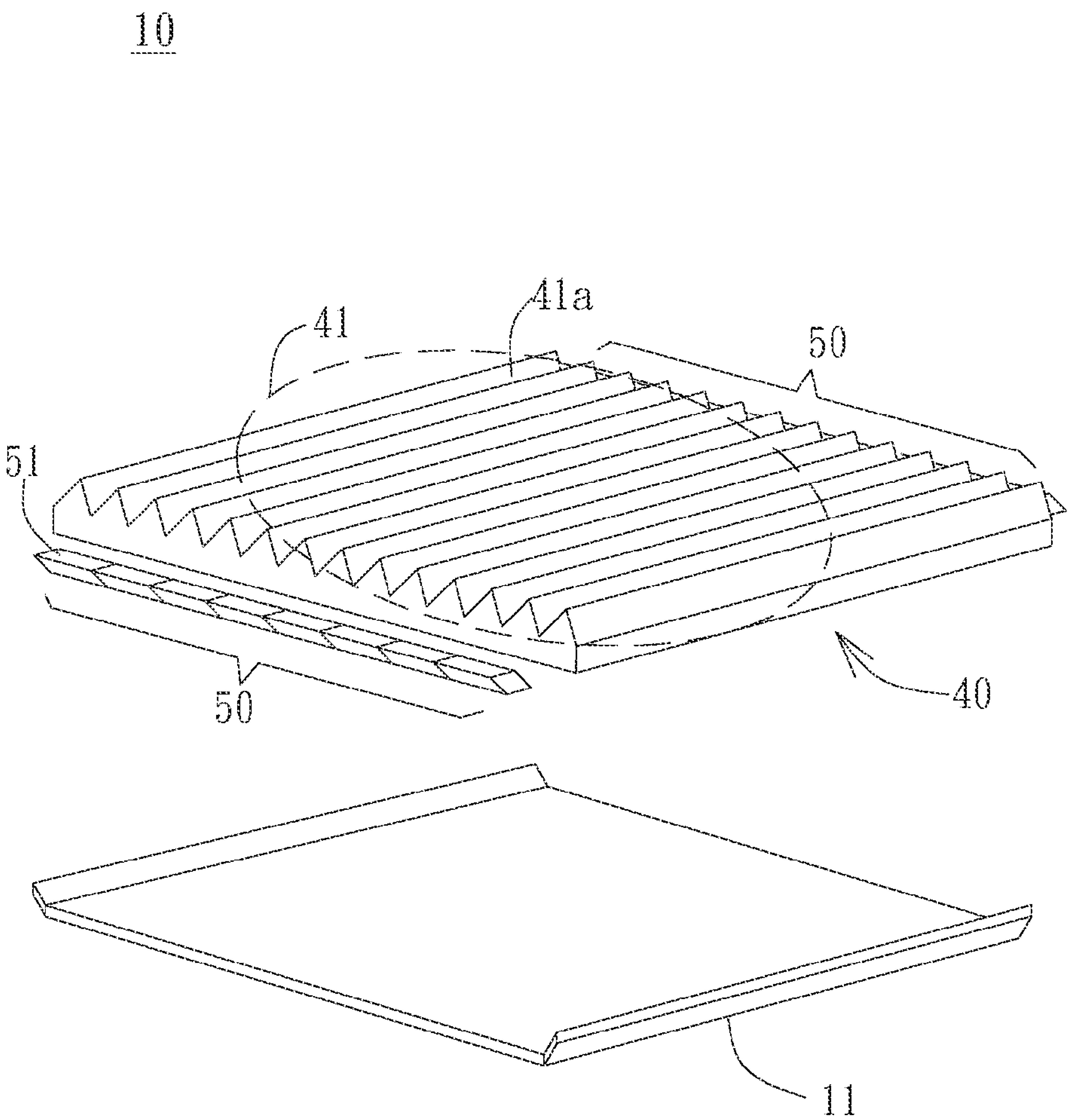


FIG. 1 (PRIOR ART)

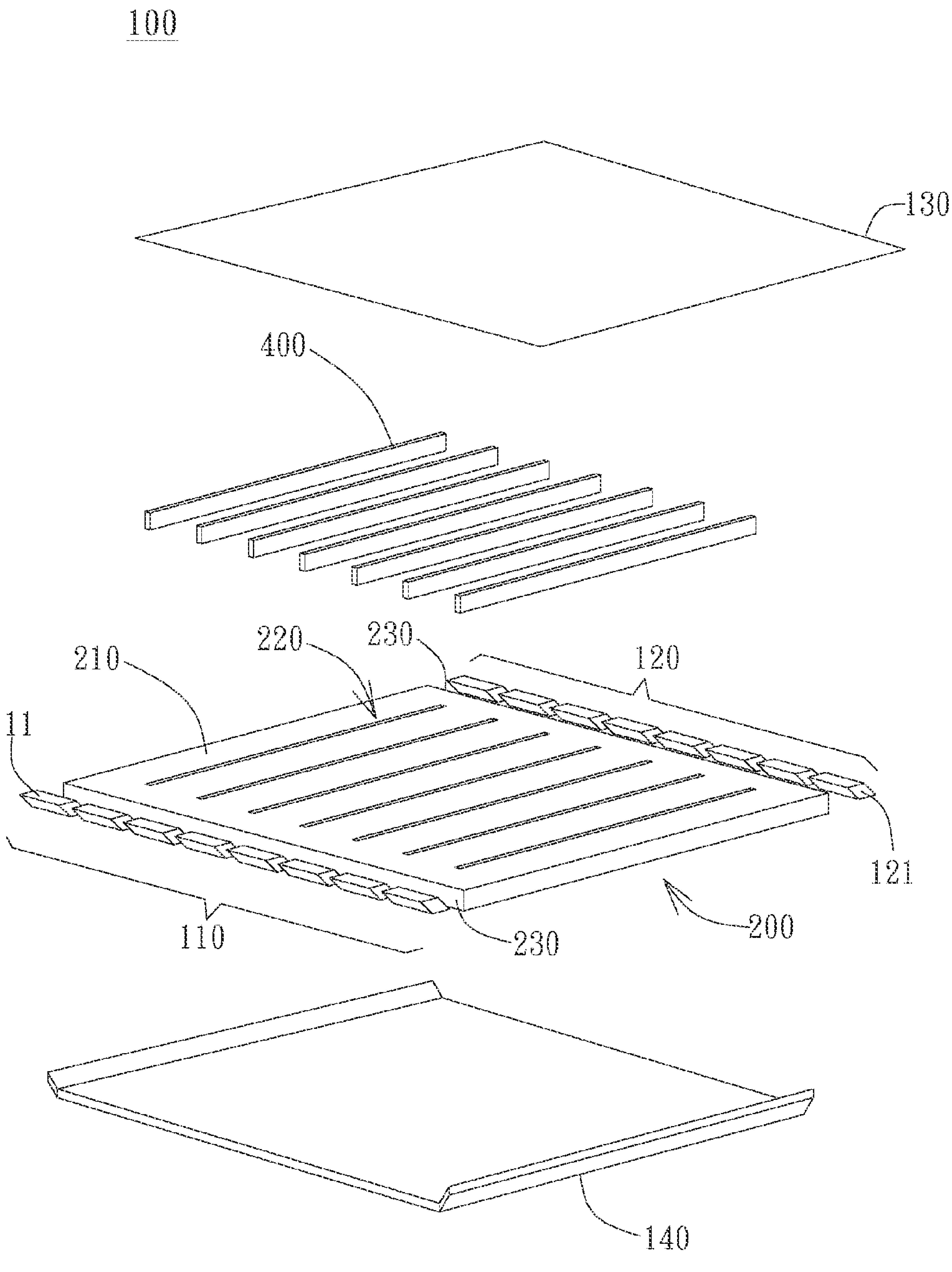


FIG. 2

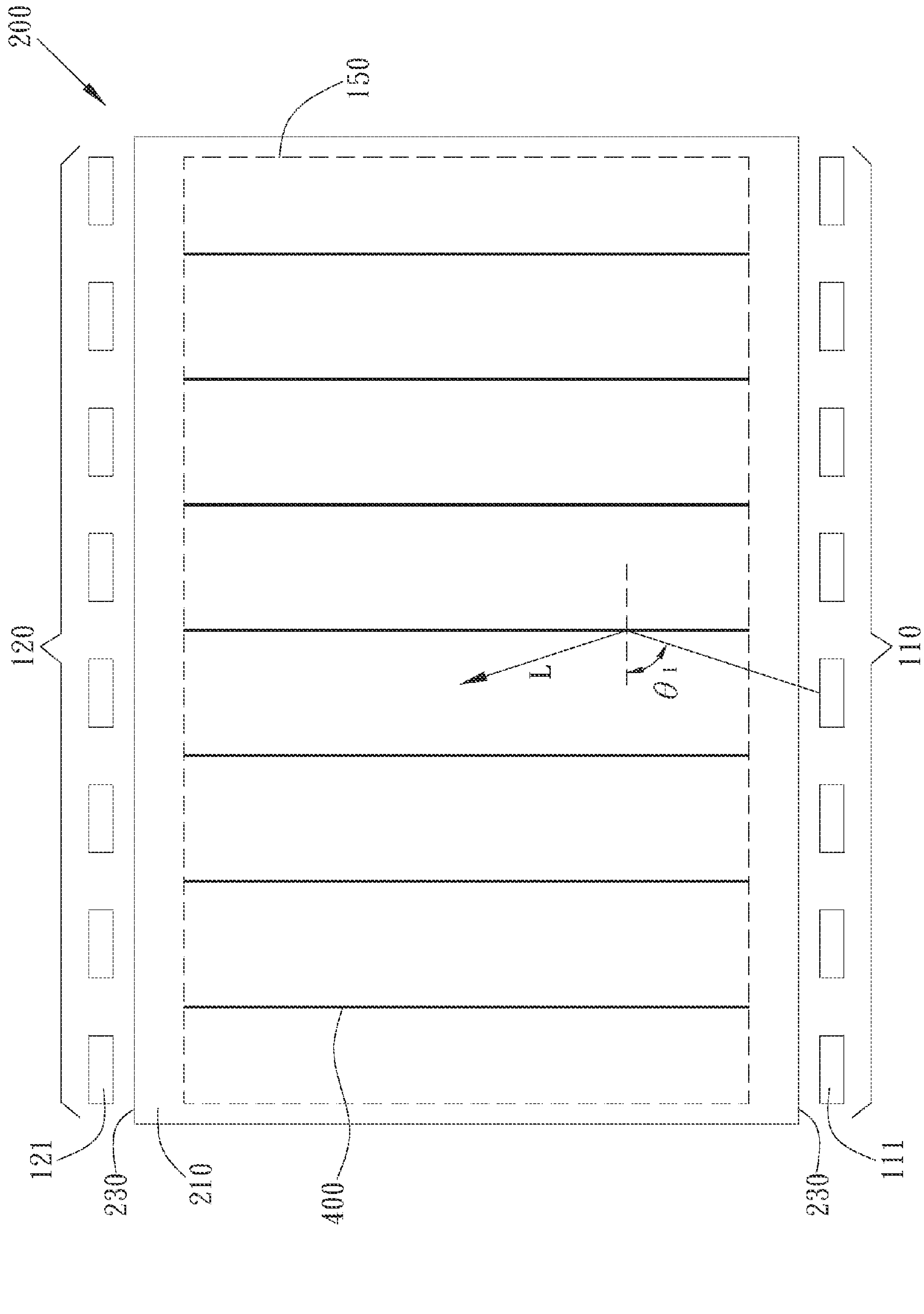


FIG. 3A

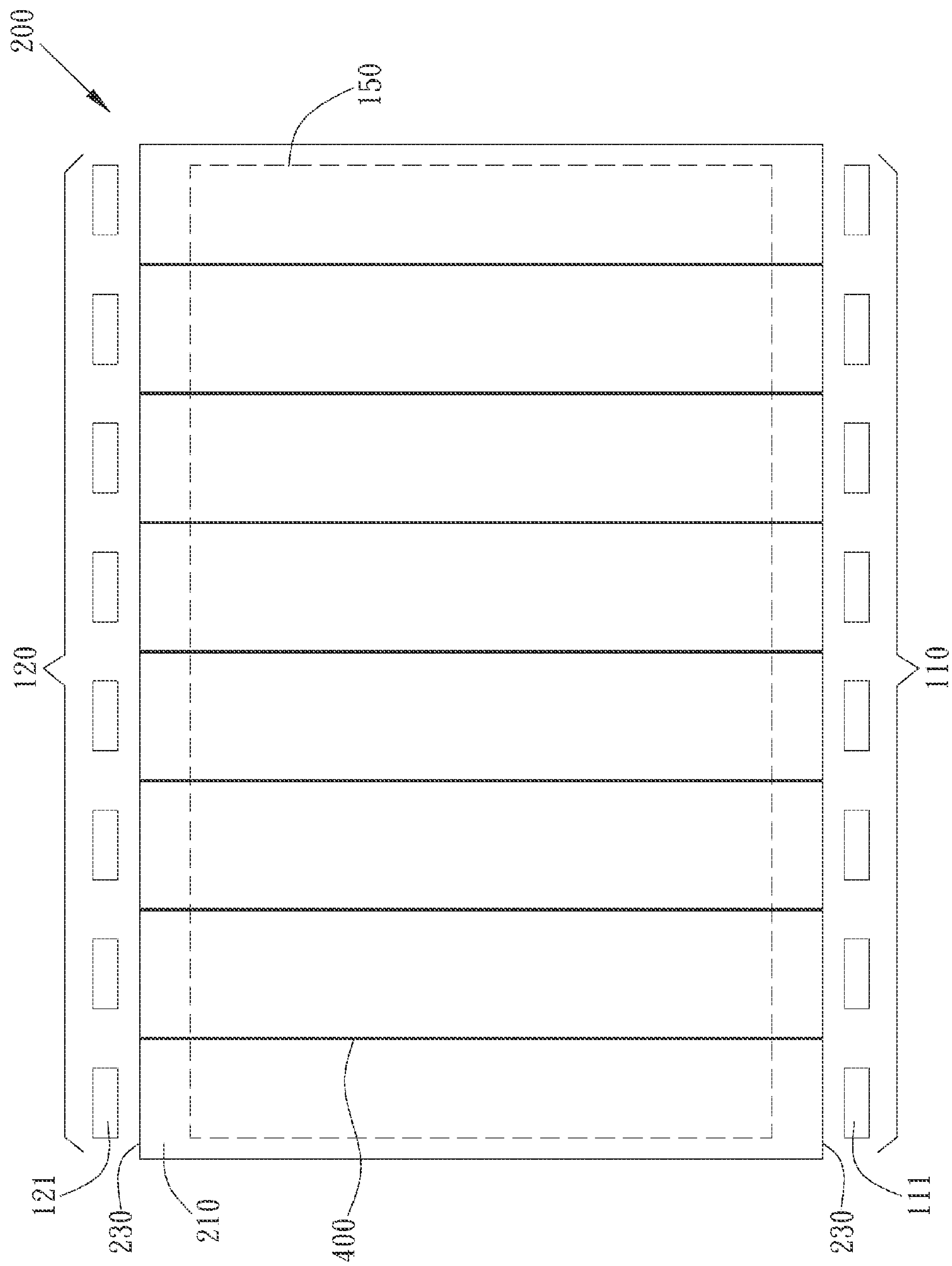


FIG. 3B

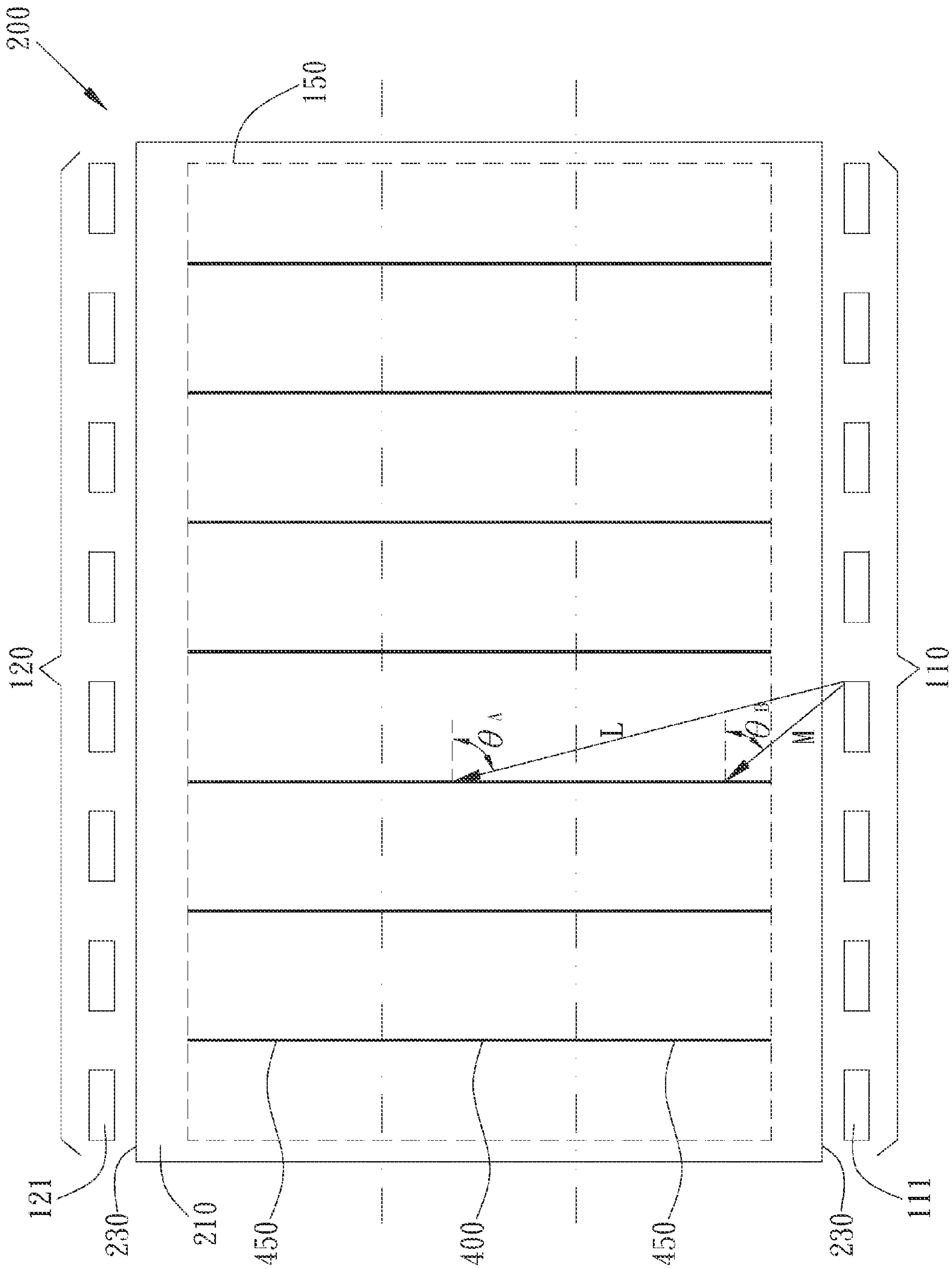


FIG. 3C

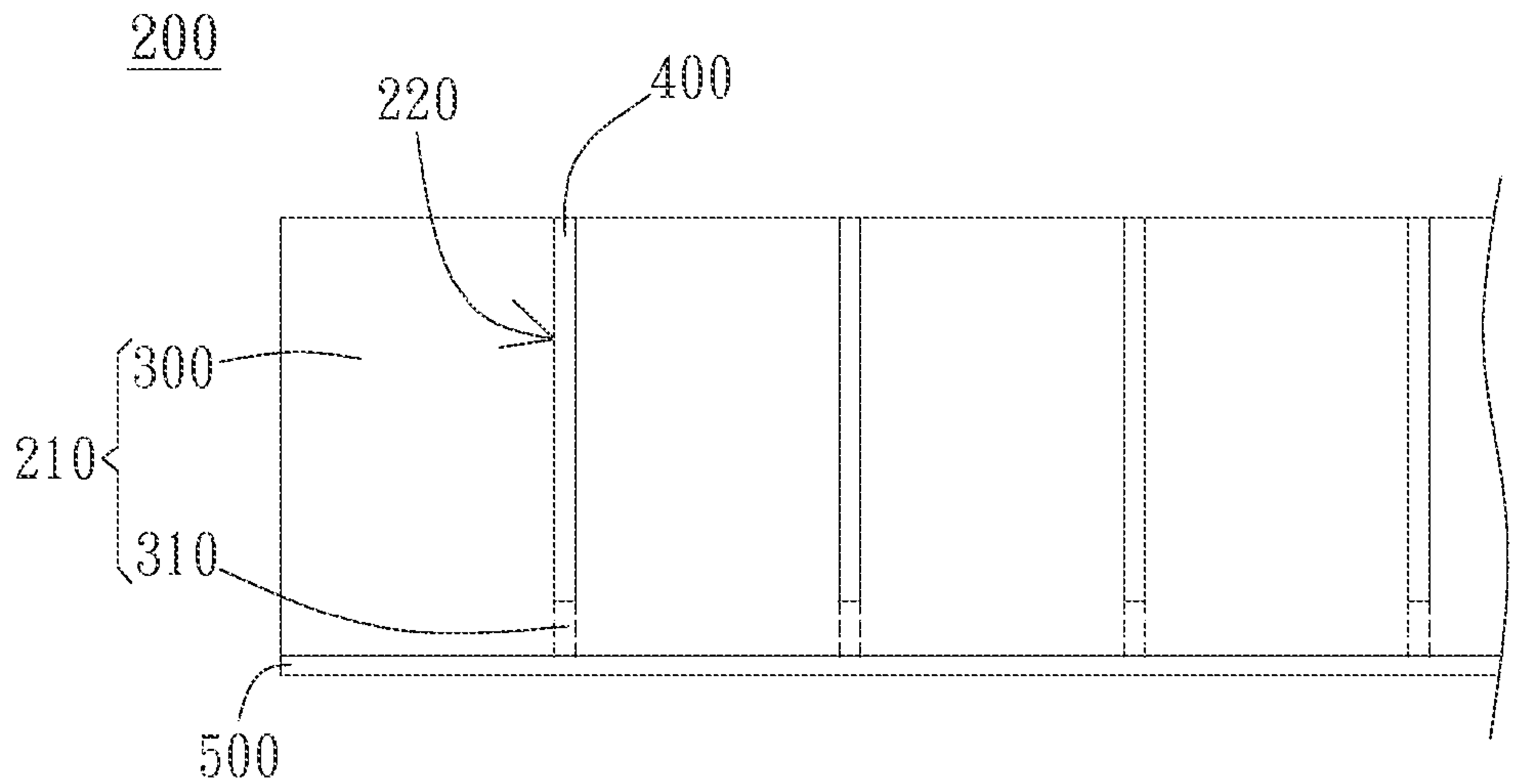


FIG. 4

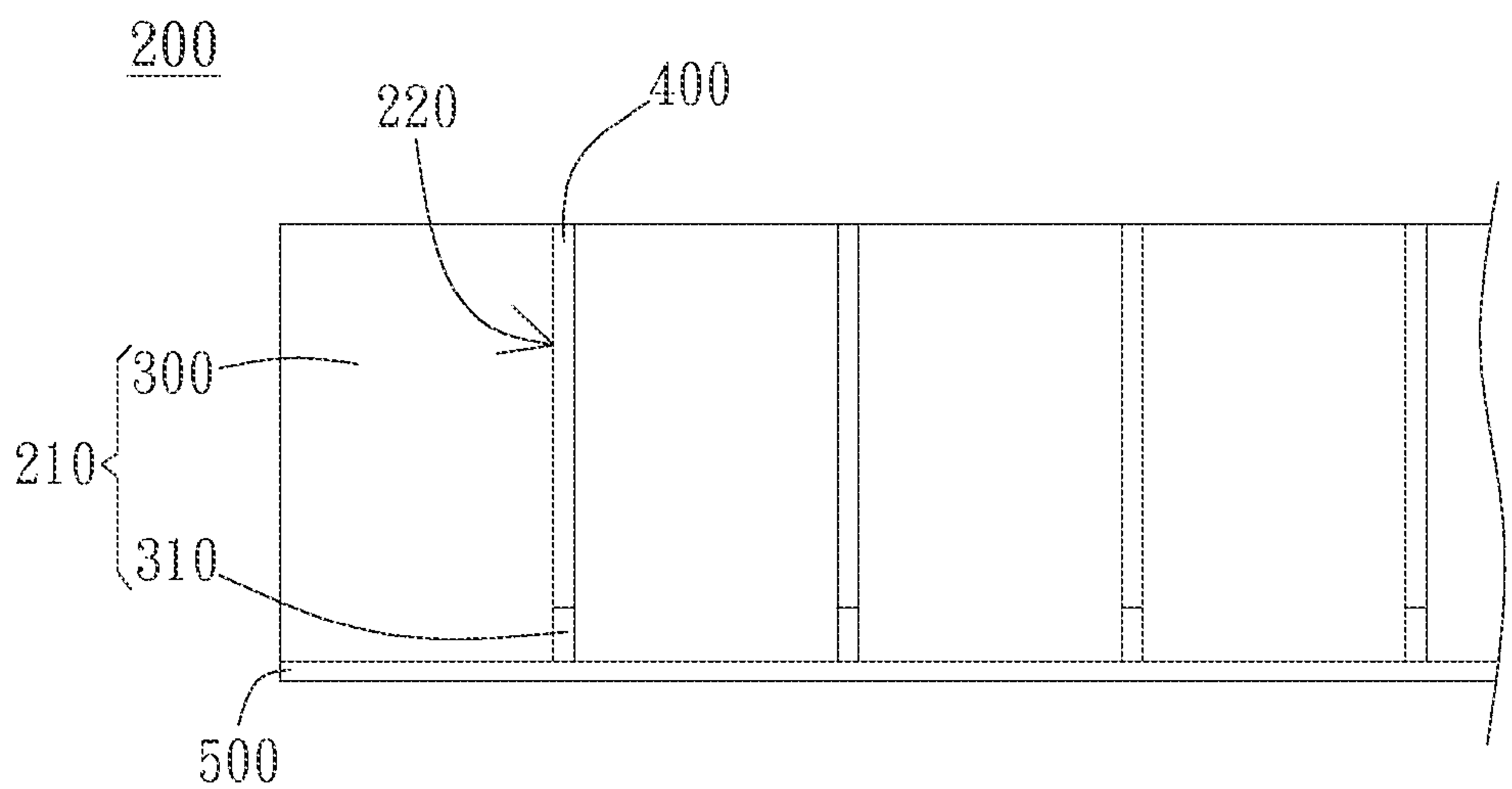


FIG. 5

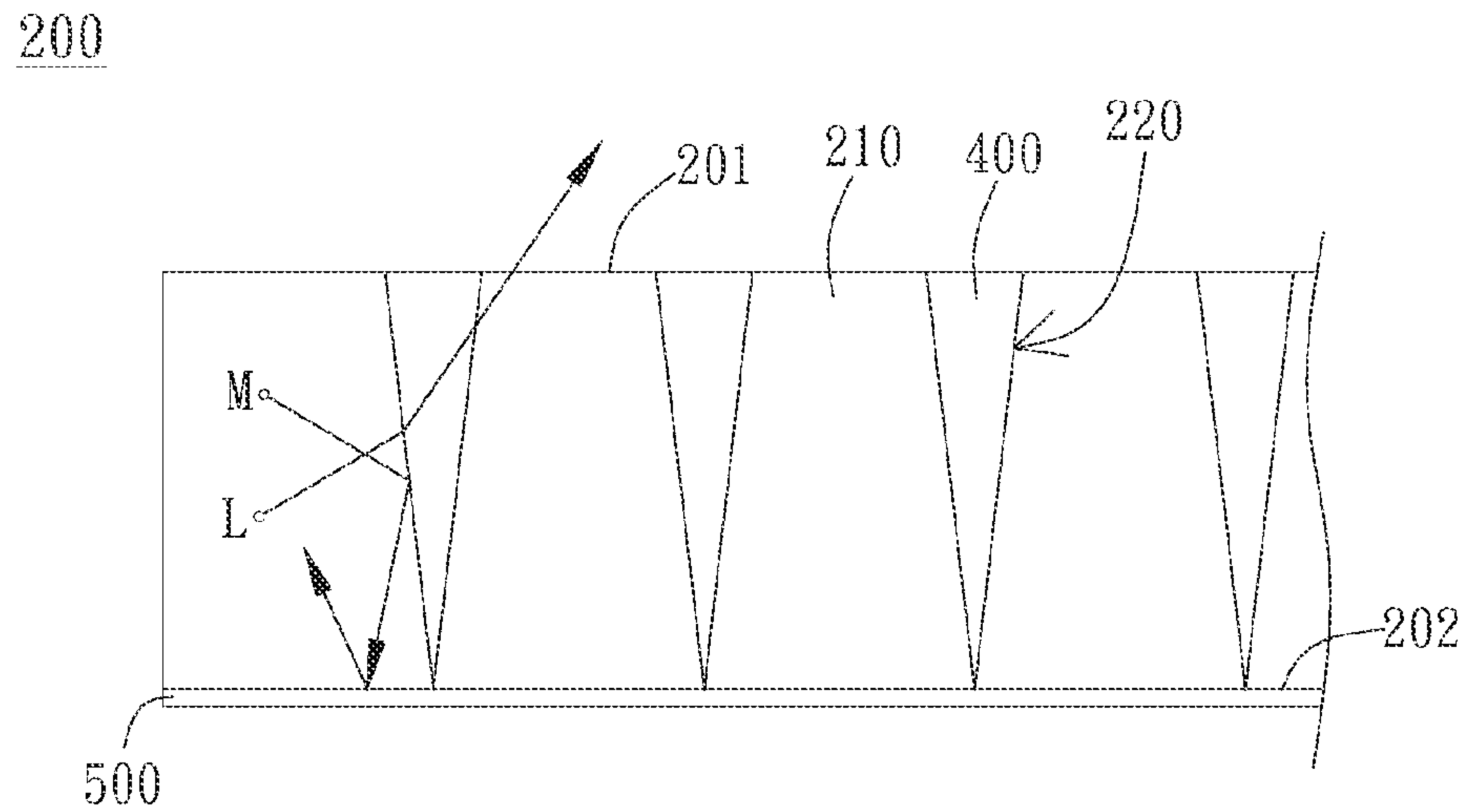
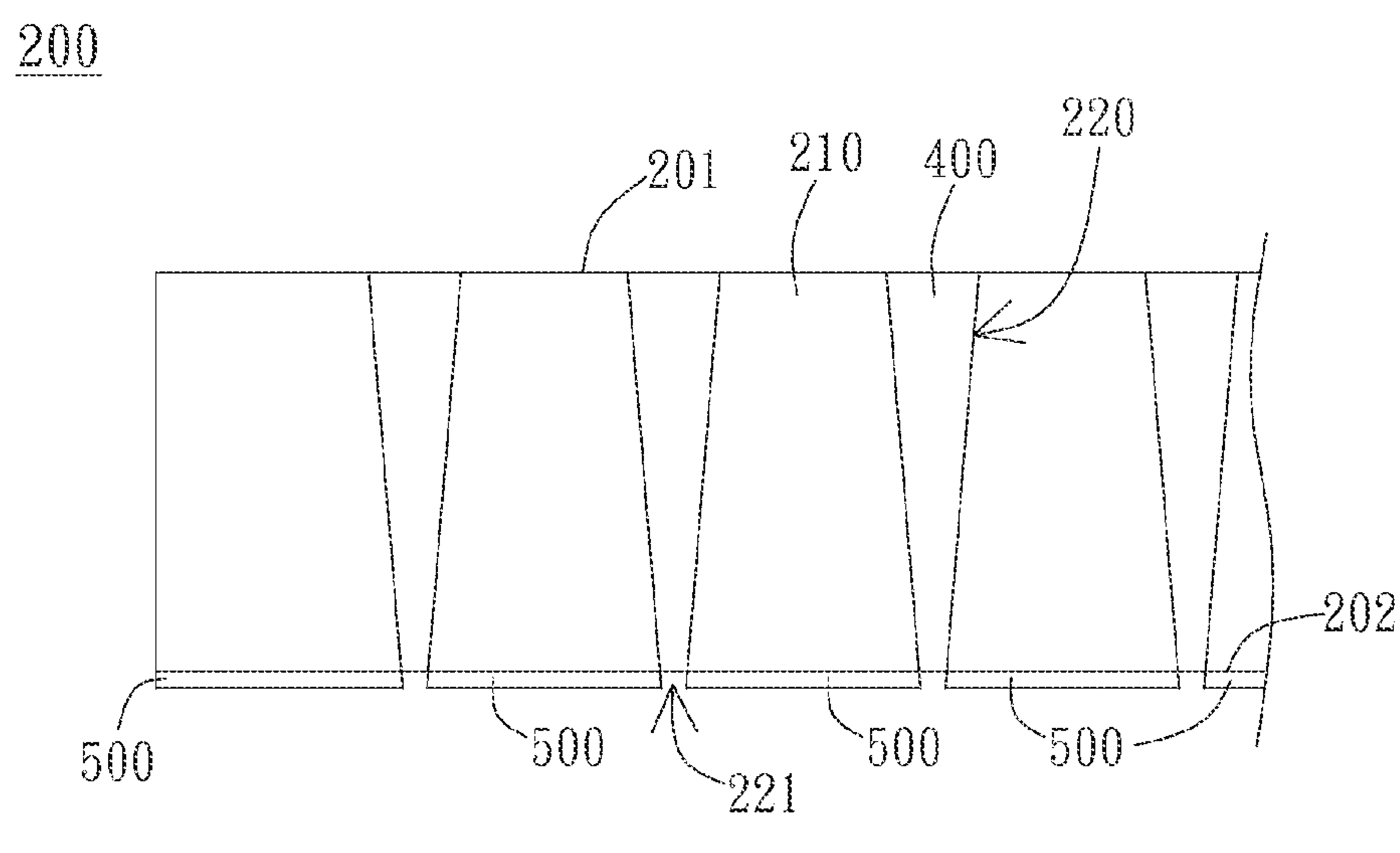

200
201
210
400
220
M
L
202
500

FIG. 6


200
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210
400
220
202
500
500
221
500
500

FIG. 7

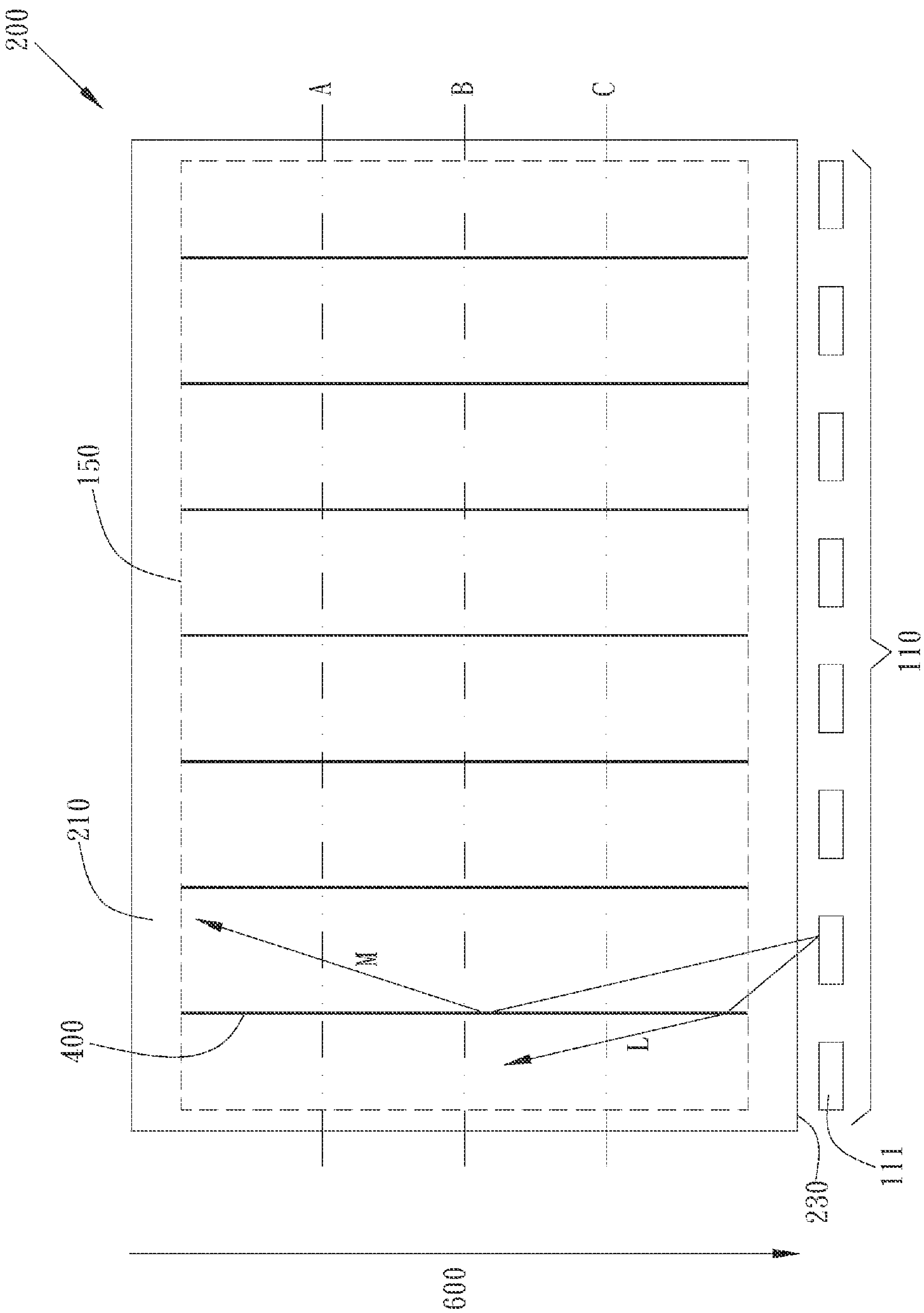

FIG. 8

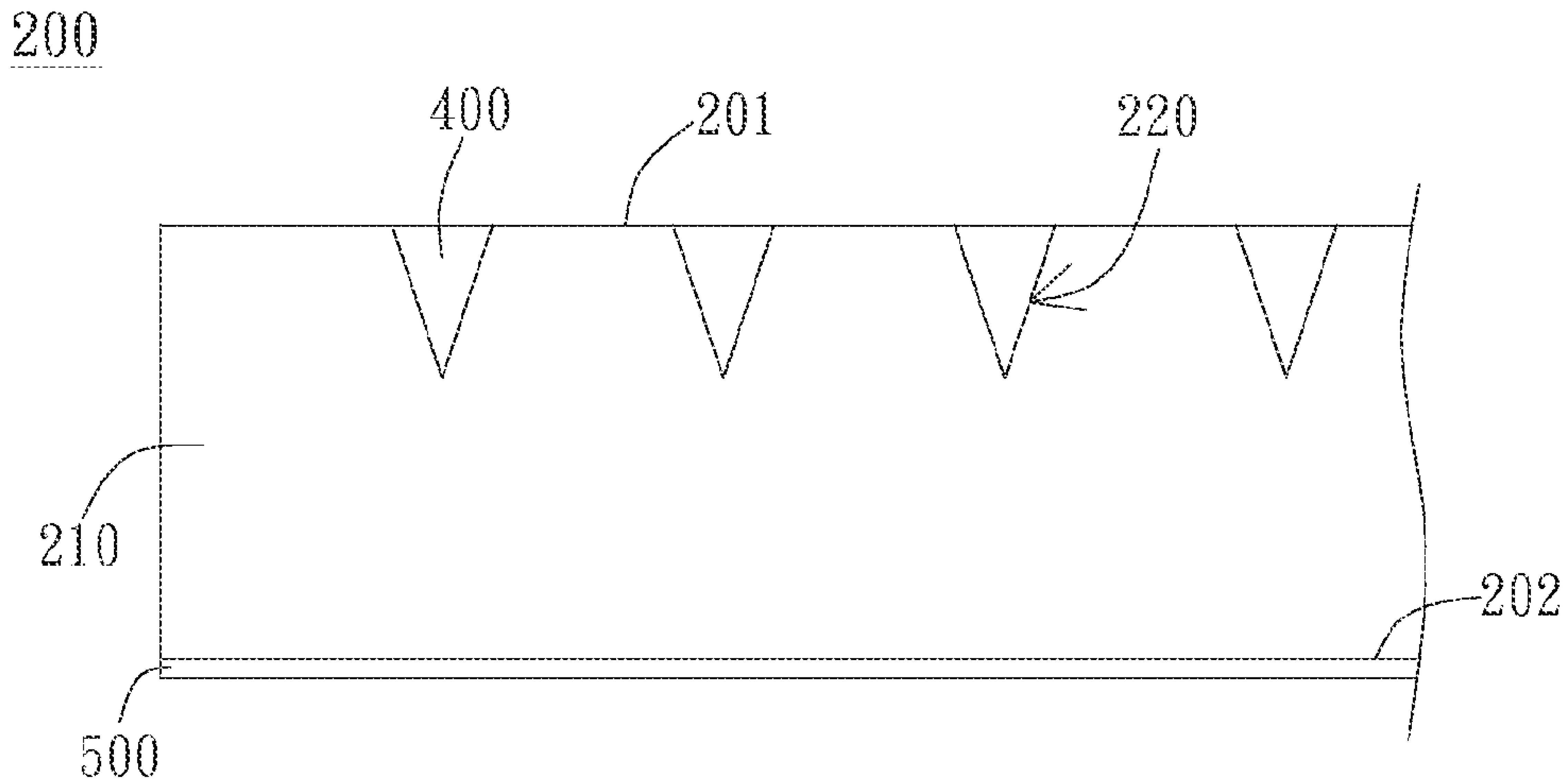

FIG. 9A

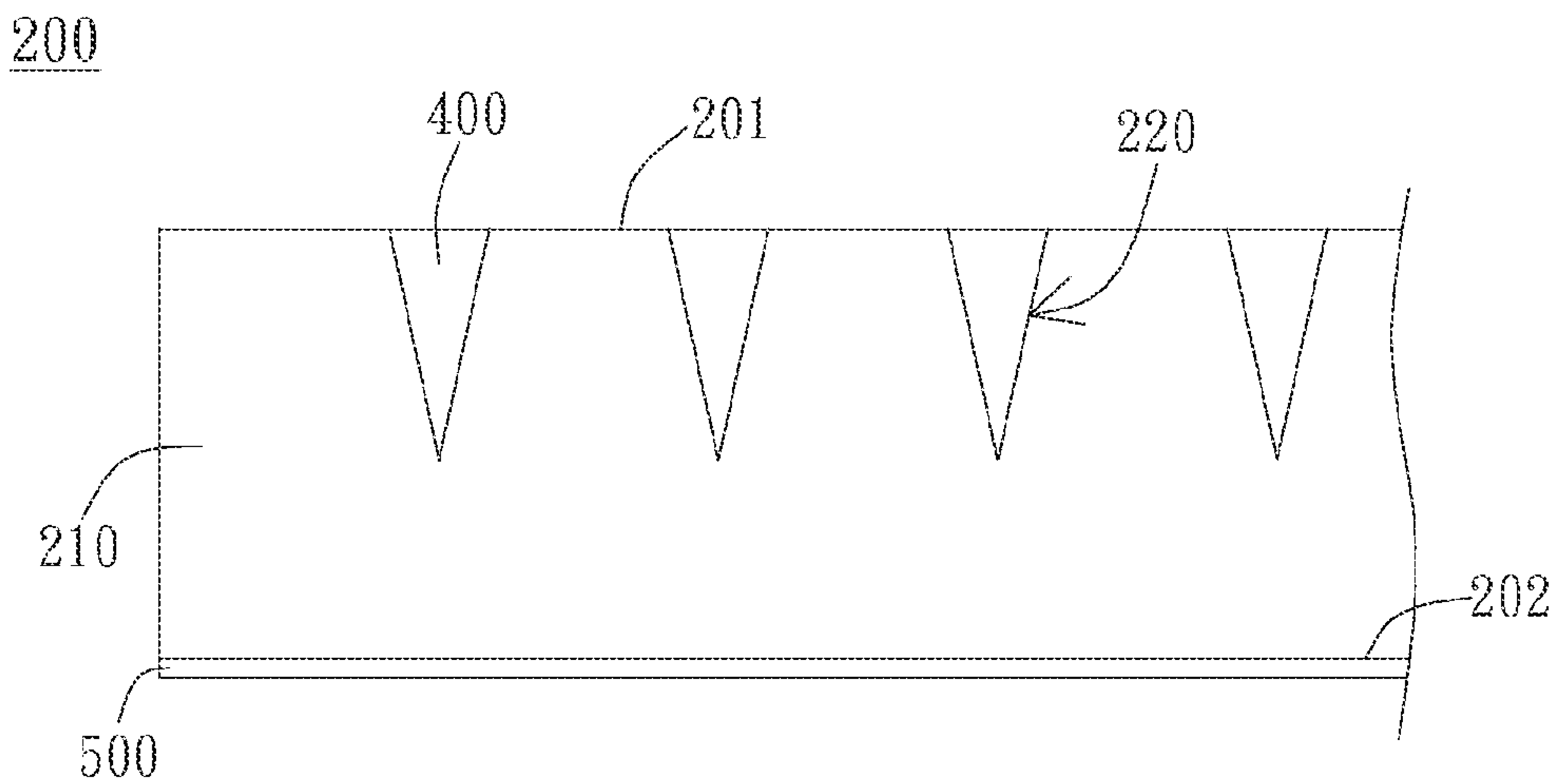

FIG. 9B

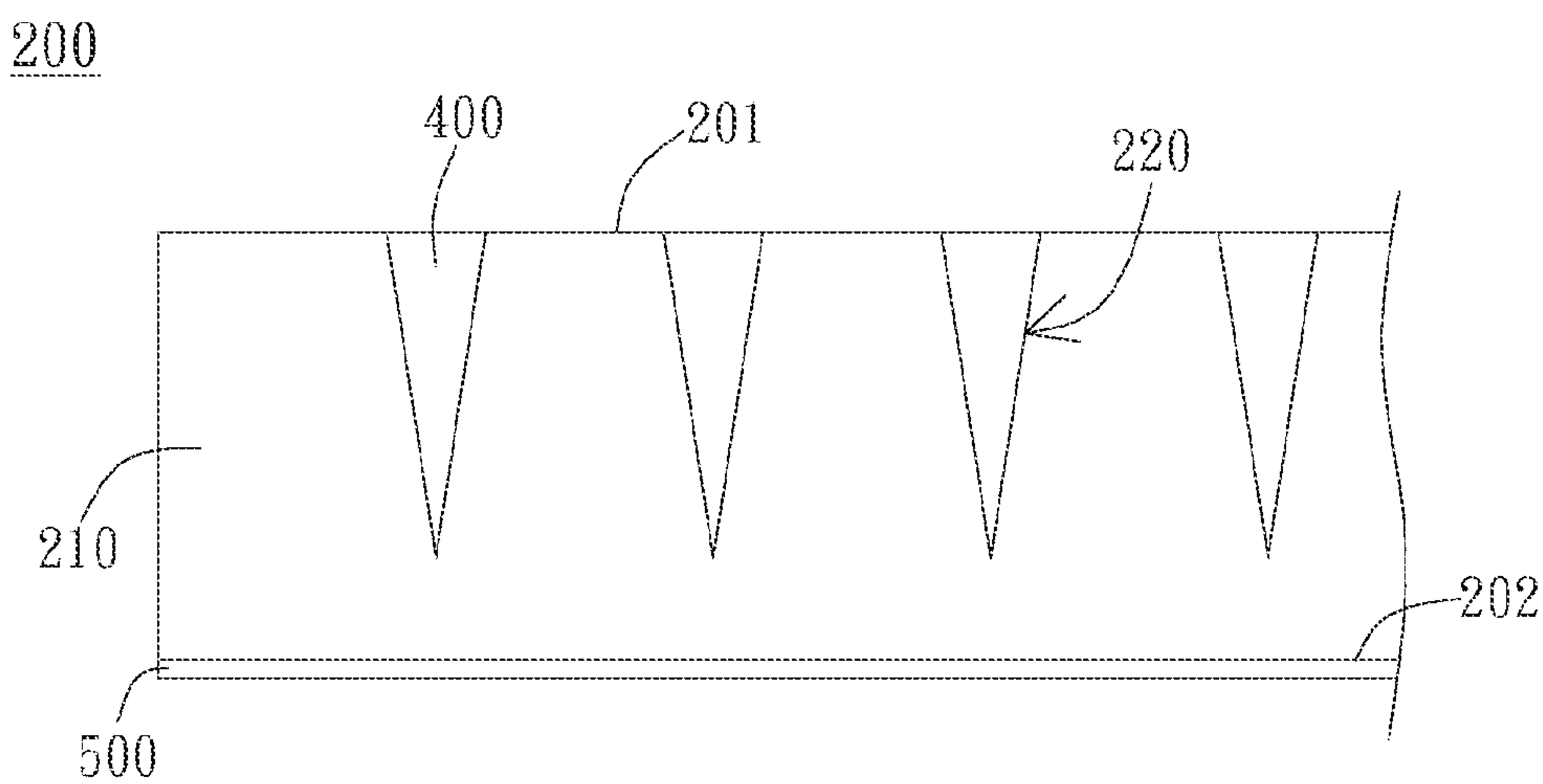

FIG. 9C

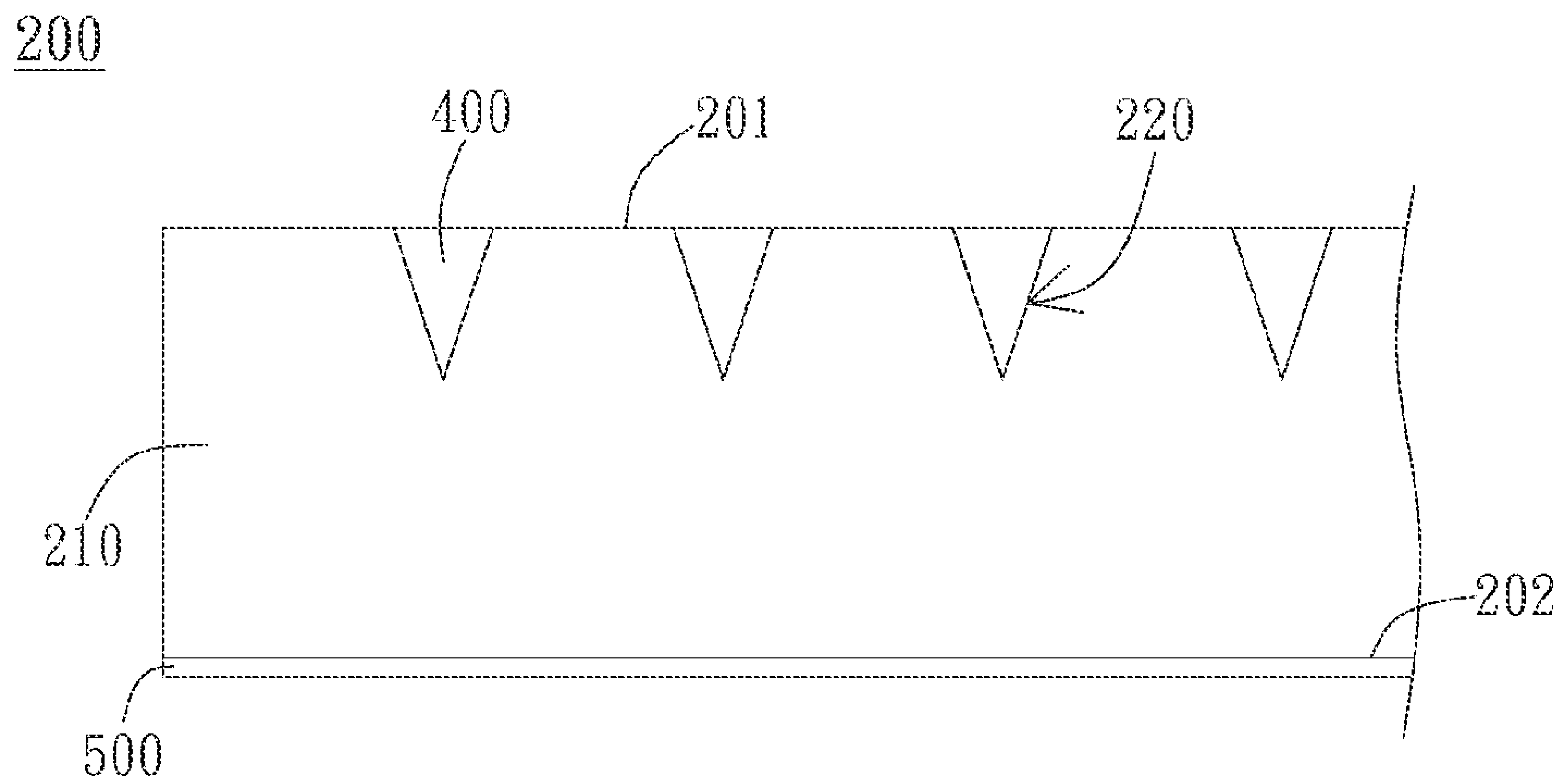

FIG. 10A

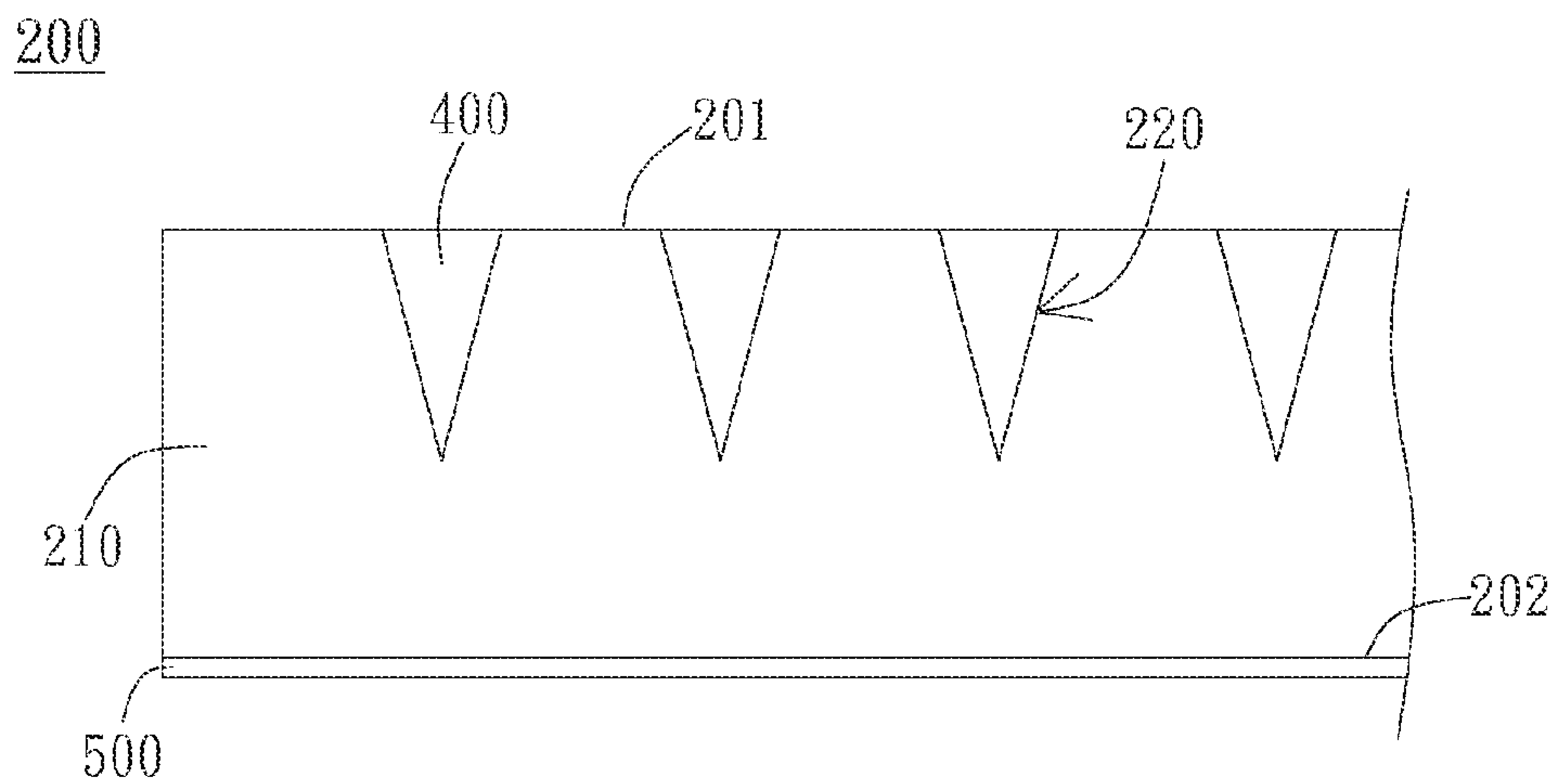

FIG. 10B

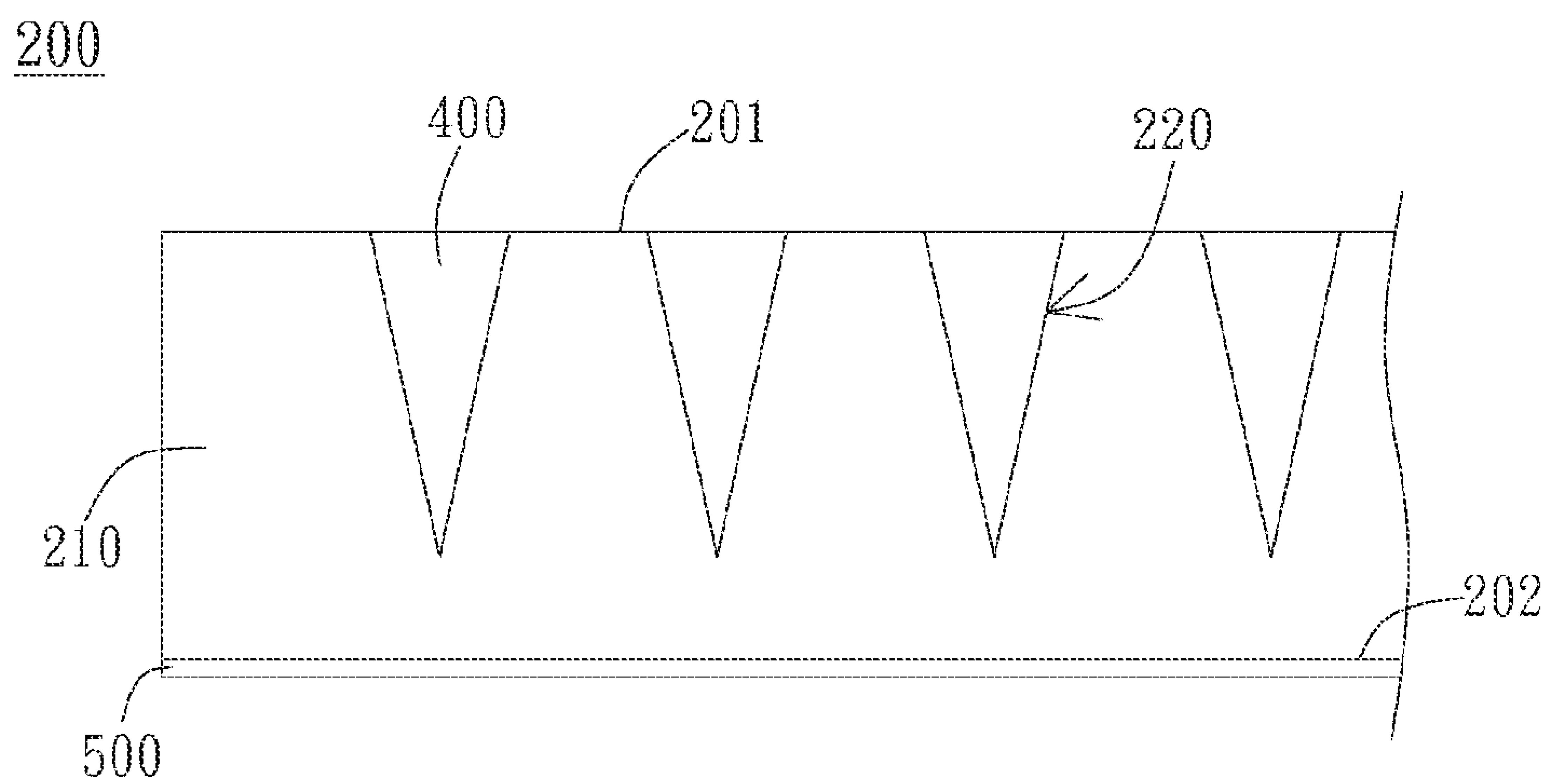

FIG. 10C

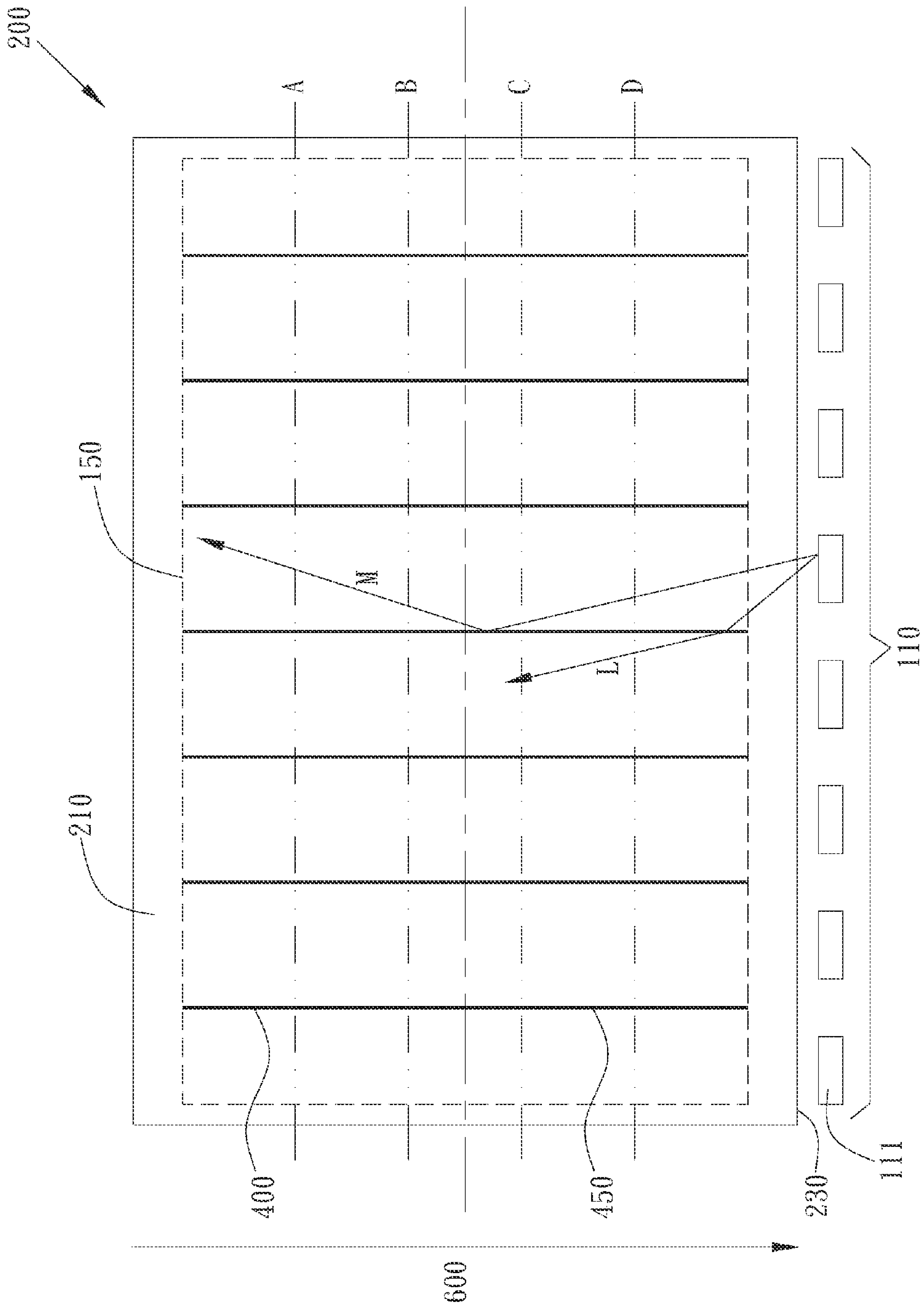

FIG. 11

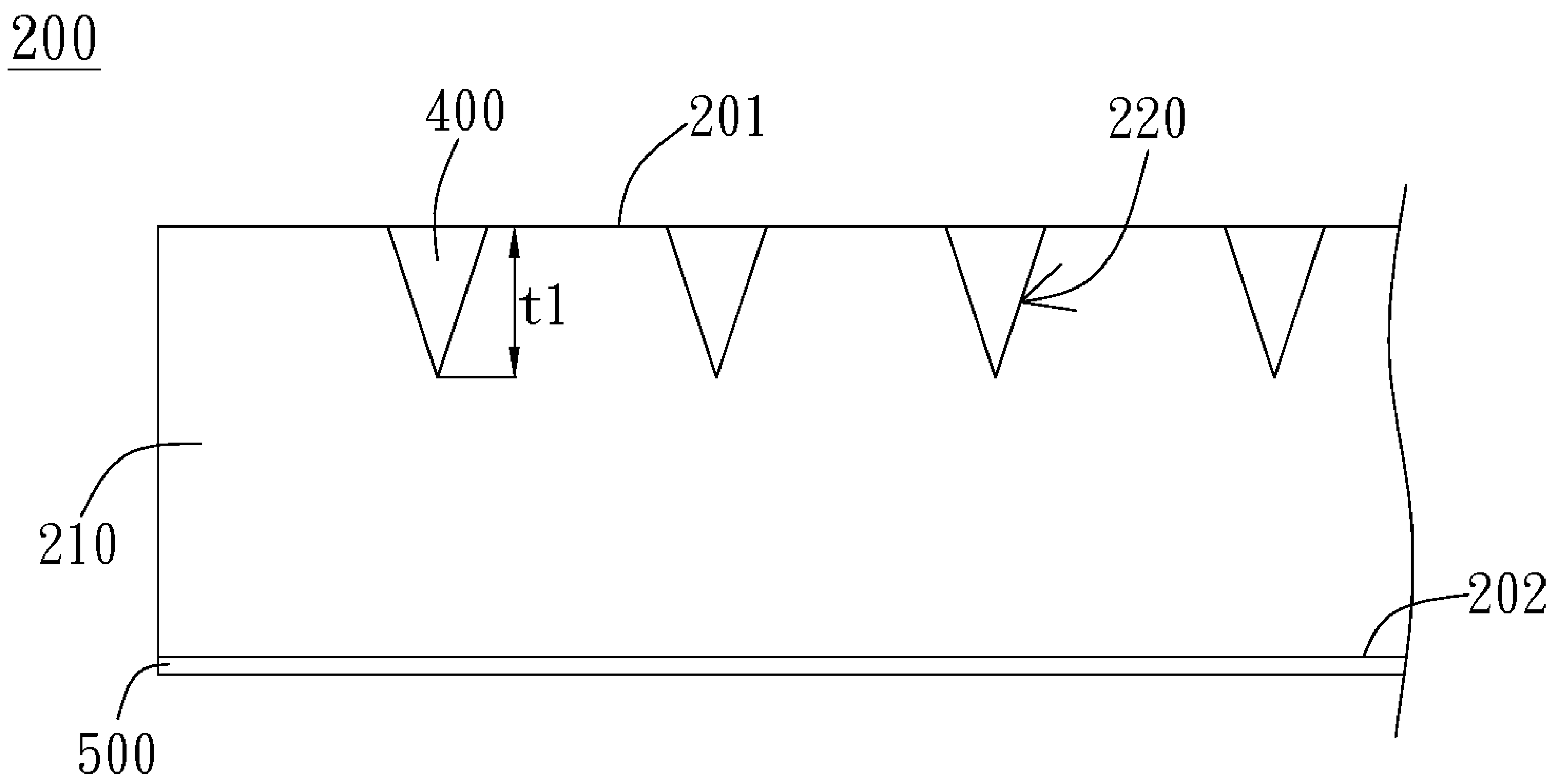

FIG. 12A

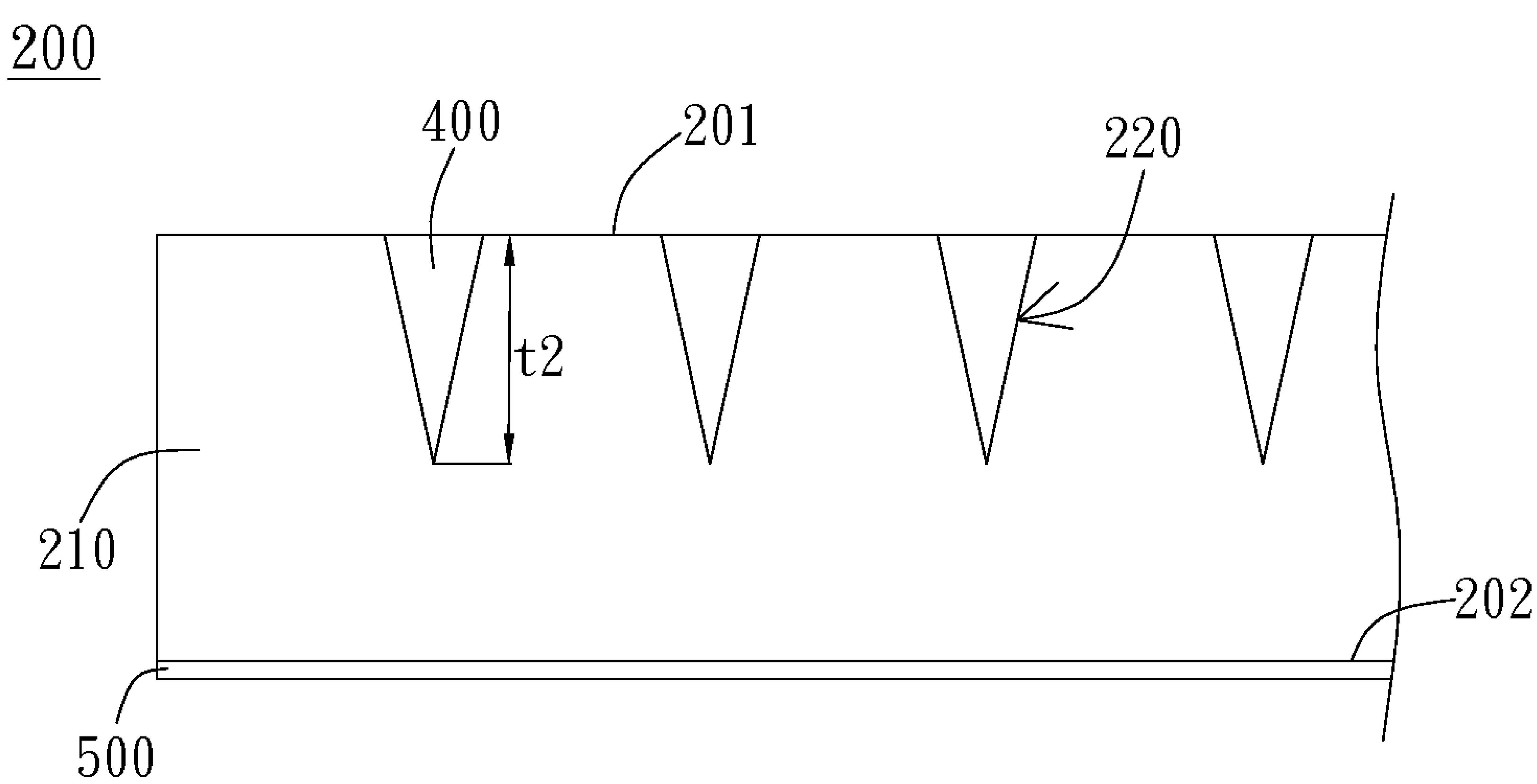

FIG. 12B

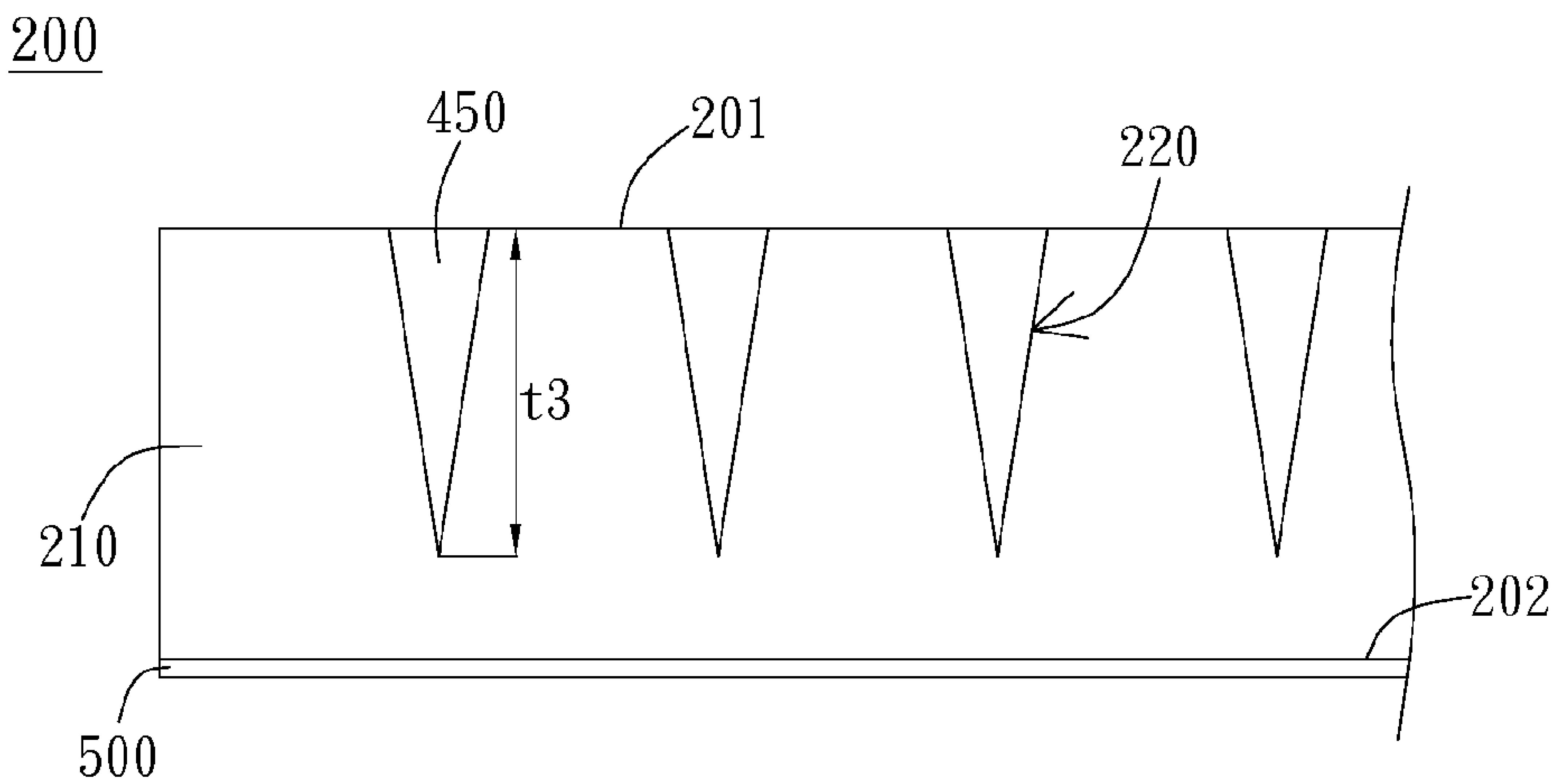

FIG. 12C

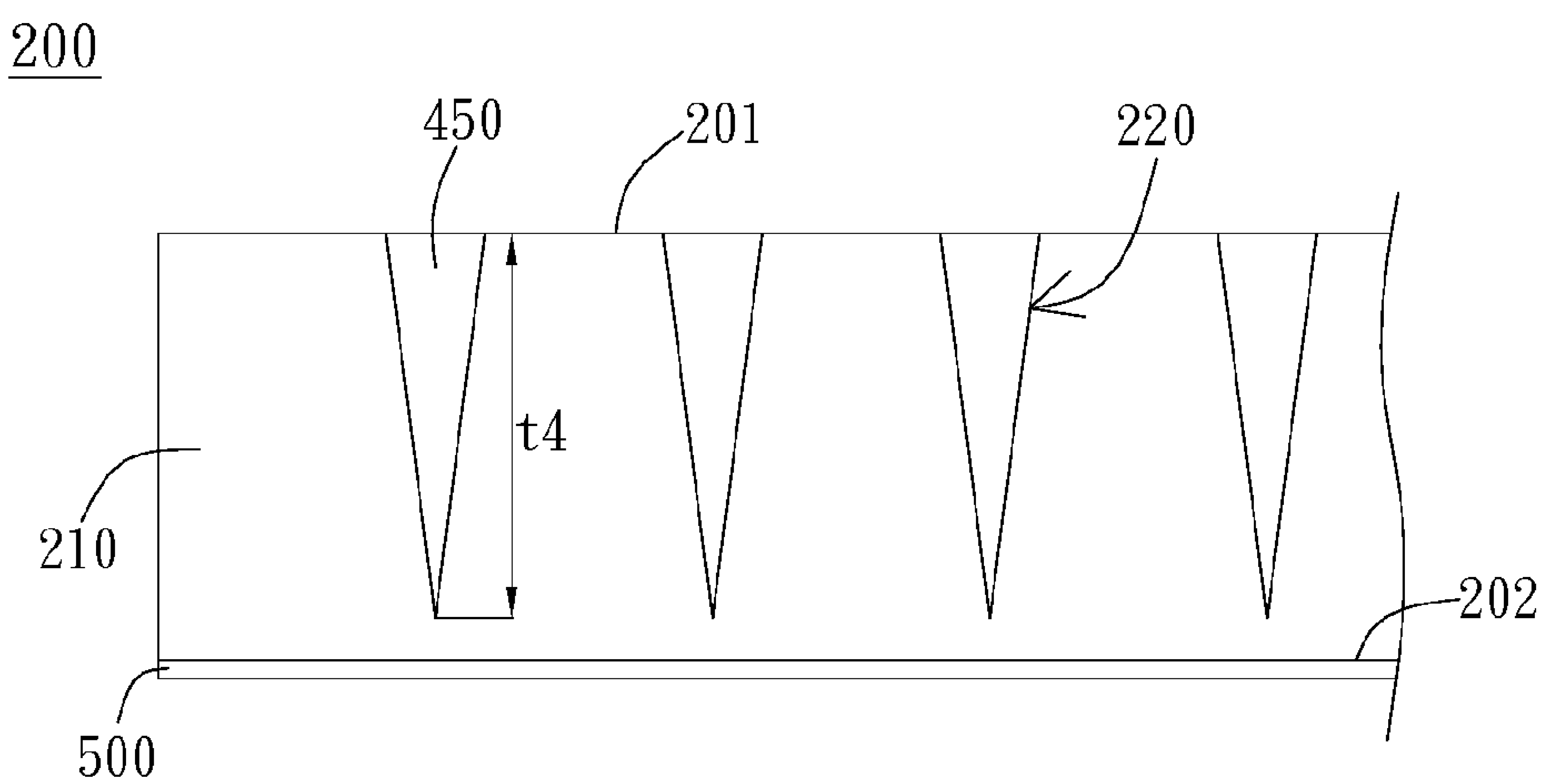

FIG. 12D

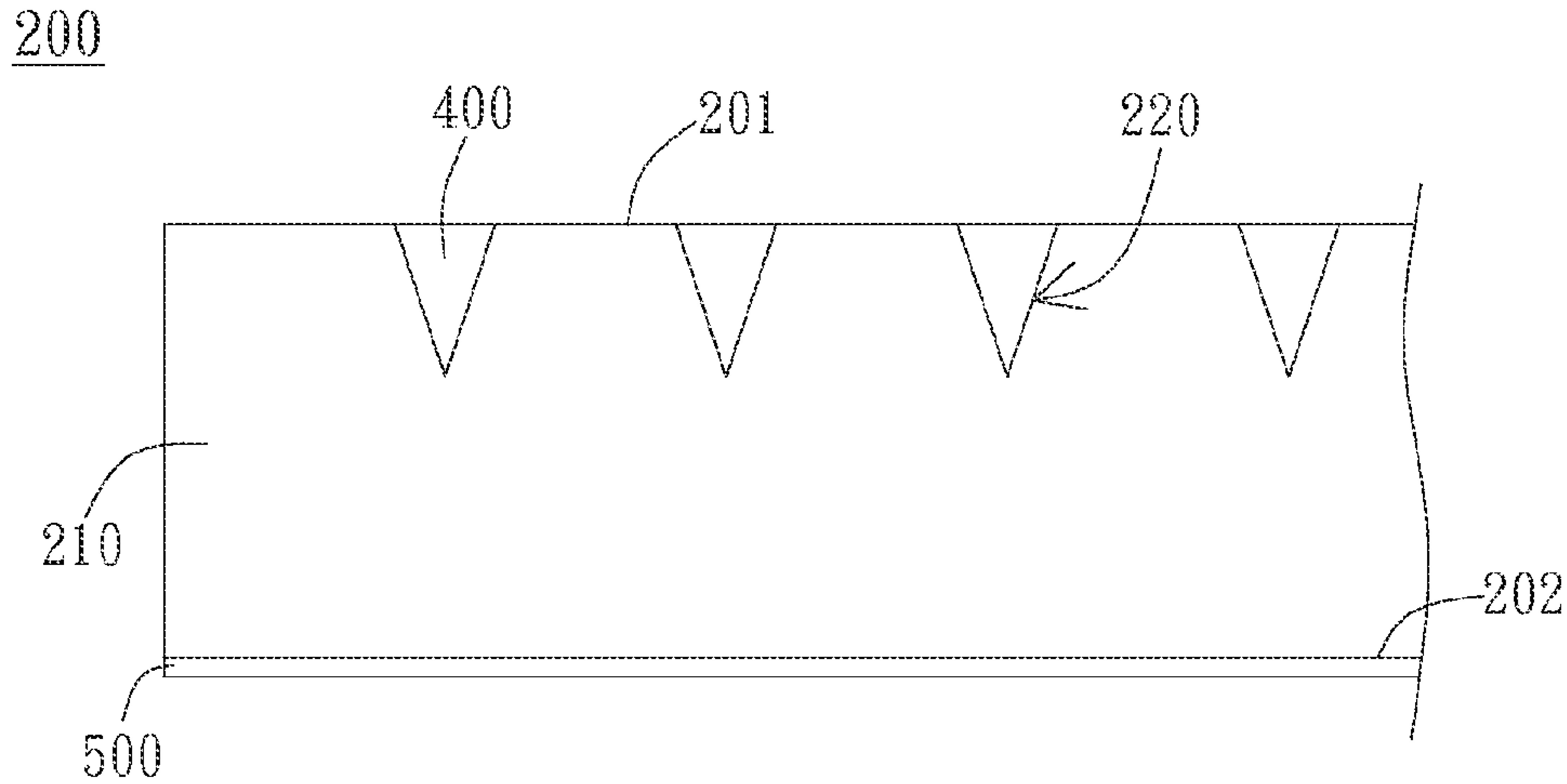

FIG. 13A

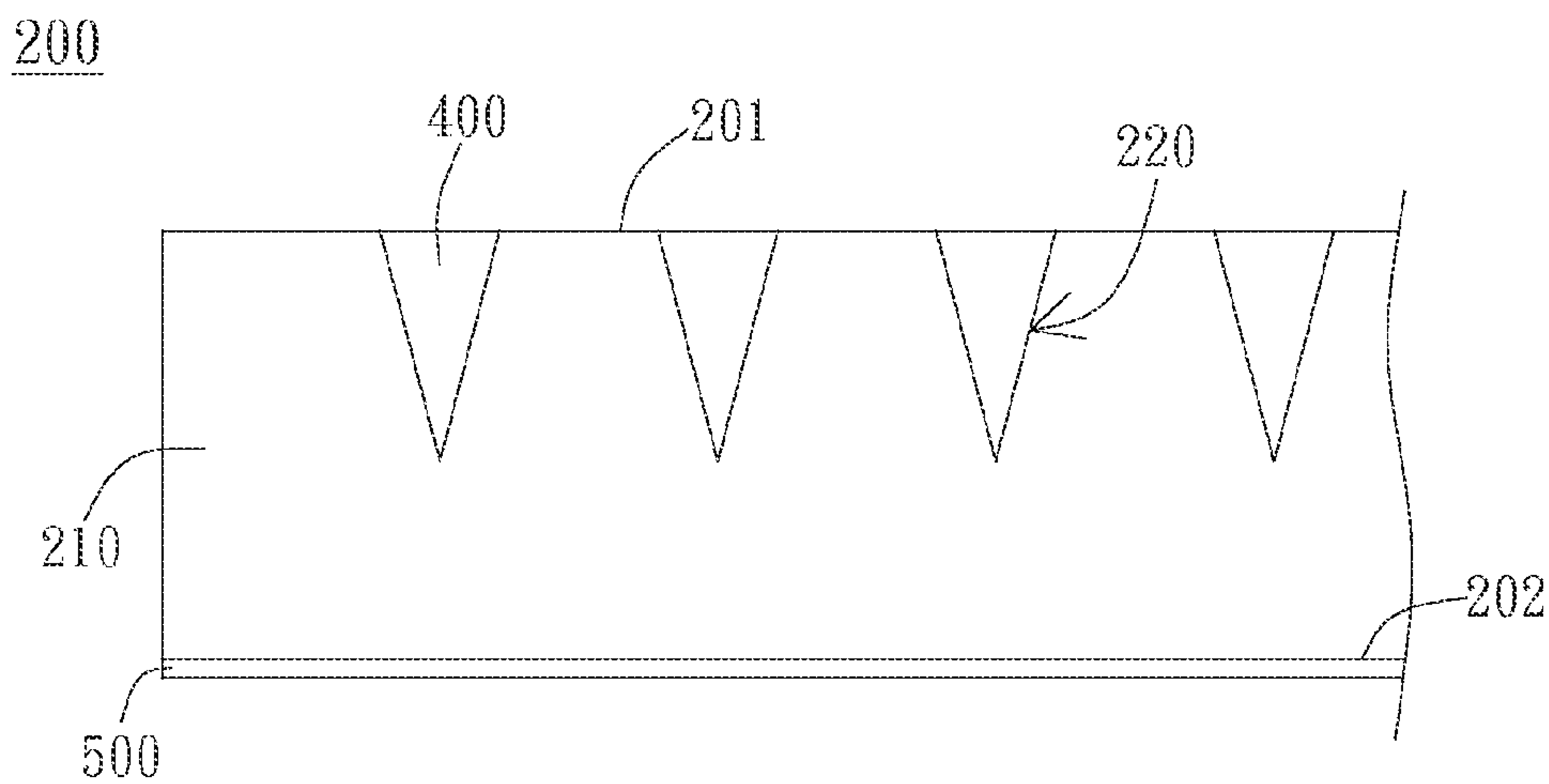

FIG. 13B

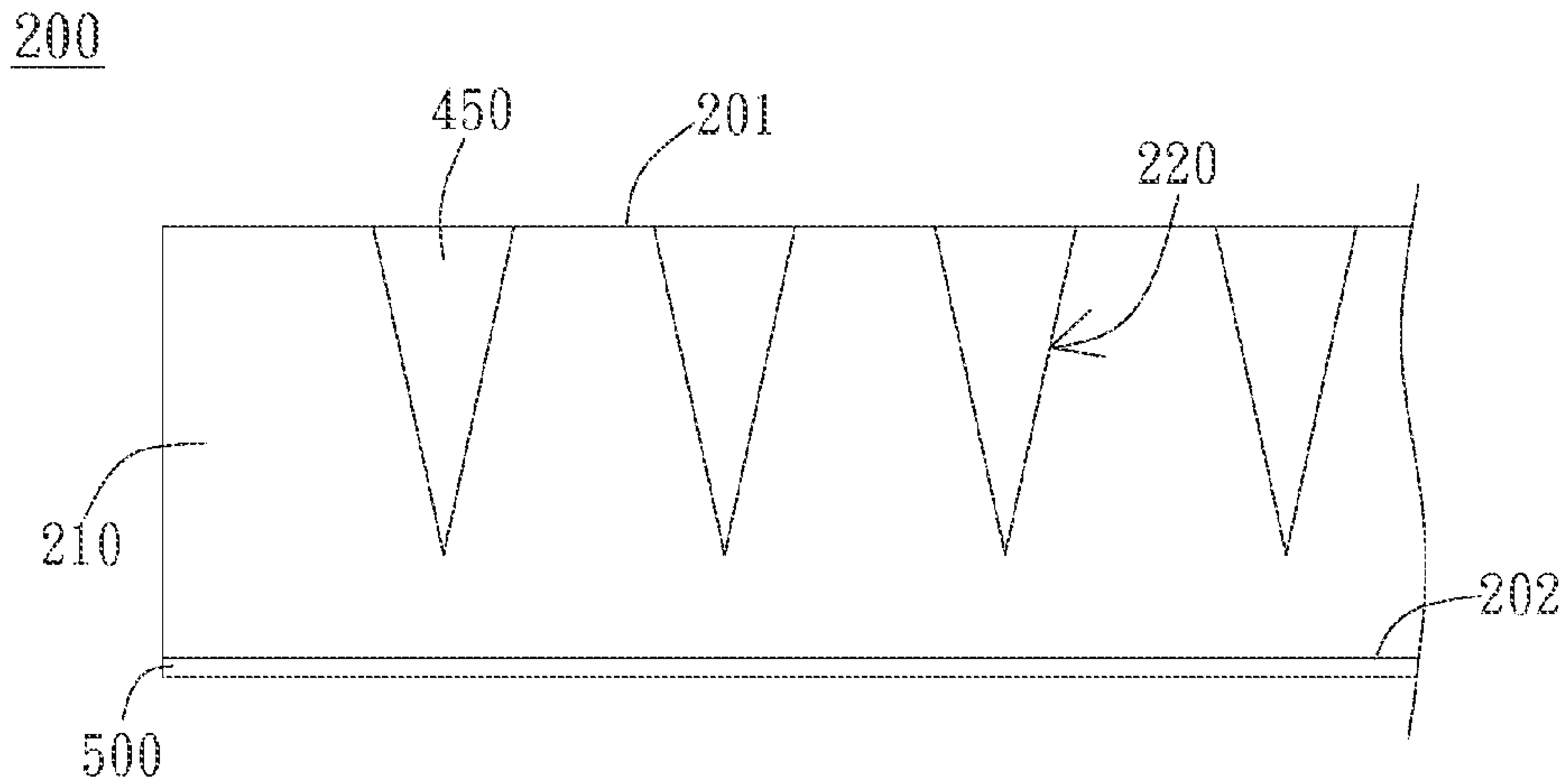

FIG. 13C

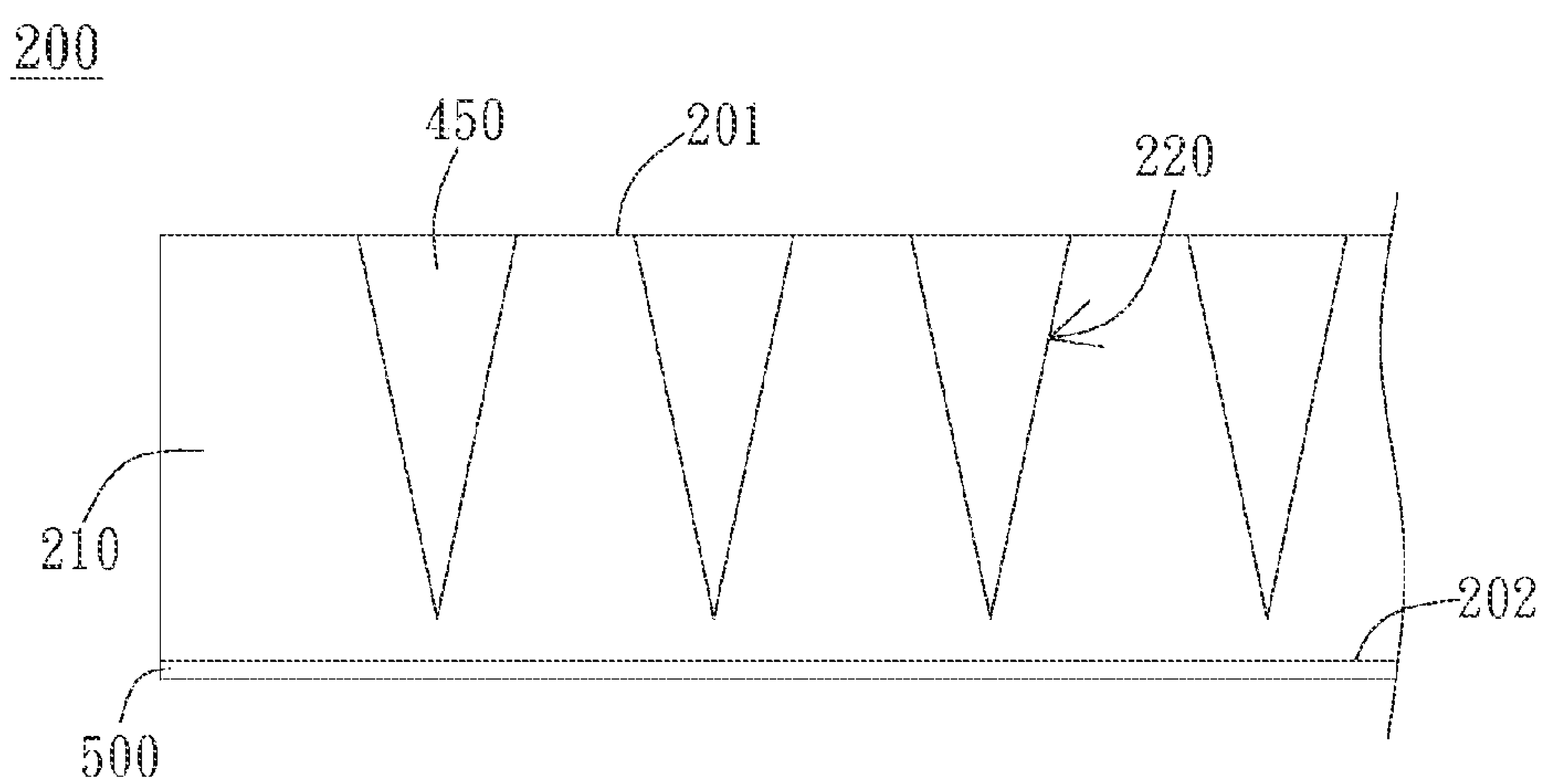

FIG. 13D

BACKLIGHT MODULE WITH LIGHT GUIDE PLATE HAVING OPTICALLY SEPARATED LIGHT GUIDE BODY

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a side-lighting light guide plate and a side-lighting backlight module, specifically to a local dimming side-lighting light guide plate and a local dimming side-lighting backlight module.

2. Description of the Prior Art

Display panels and flat displays using the display panels are now the mainstream of the display devices. In addition, the liquid crystal displays are the mainstream of the flat displays and are extensively used in various types of electronic products such as display screens, home televisions, monitors for personal computers and laptop computers, display screens of mobile phones and digital cameras.

The backlight module is one of the key components of the conventional liquid display panels. The liquid crystal itself does not generate light and a backlight module is used to provide adequate and evenly distributed luminance for the liquid crystal display panel to display images properly. The conventional backlight module uses only a single light guide plate to guide the light generated by the light sources, wherein the luminance at different portions of the light guide plate is substantially equal. However, in order to improve the visual effect of the displayed images, the backlight module should be able to present luminance of different magnitudes at different portions of the light guide plate.

As for the conventional direct-lighting backlight module, the light sources are disposed directly below the display panel. In this way, the direct-lighting backlight module only needs to drive the light source below the portion of the light guide plate needing luminance and close other light sources to achieve the desired contrast of the display image. However, for the side-lighting backlight module, light generated by the light sources enters the light guide plate and then disperses as the moving distance increases. In other words, the light guide plate cannot limit the light in one particular region. In this way, the conventional side-lighting backlight module cannot achieve the desired contrast by driving and closing the light sources like the conventional direct-lighting backlight module.

FIG. **1** is an exploded view of a conventional side-lighting backlight module **10**. As FIG. **1** shows, the side-lighting backlight module **10** includes a reflector **11**, a light guide plate **40**, a light source set **50**, wherein the light source set **50** is disposed at two sides of the light guide plate **40**.

In the embodiment illustrated in FIG. **1**, the light source set **50** includes a plurality of light sources **51**, wherein the light sources **51** can be light emitting diodes. Similarly, different portions of the light guide plate **40** are defined by the light sources **51** as a plurality of light areas, wherein each light area of the light guide plate **40** corresponds to one or more different light sources **51**. The light source **51** thus can be selectively driven to provide the corresponding light area with the required luminance.

As FIG. **1** shows, an upper structure layer **41** is disposed on the surface of the light guide plate **40**. The upper structure layer **41** includes a plurality of prisms **41***a*, wherein the prism **41***a* extends from one side of the light guide plate **40** near the light source set **50** toward the opposite side near another light source set **50**. The extending direction of the prism **41***a* is parallel with the travelling direction of the light emitted by the light source set **50**. In this way, lights generated by the light source set **50** travel in the extending direction of the prism **41***a* toward the opposite sides of the light guide plate **40** and will not greatly disperse in other directions. This helps with the control of luminance in light areas. For this reason, the extending directions of the prisms **41***a* are substantially parallel, but are not limited thereto; in different embodiments, an angle can be included between the extending direction of the prisms **41***a* and the extending direction of the light.

A microstructure layer is disposed at the bottom of each light area of the light guide plate **40** for destroying the total reflections of the lights so that those lights can eventually emit from the surface of the light guide plate **40** that is disposed with the upper structure layer **41**.

However, the light guide plate **40** is integrally formed into one piece by same material. There is thus no other structure or material for blocking light generated by adjacent light sources **51**. In this way, only a portion of the light generated by the light source set **50** will travel in a direction parallel with the extending direction of the prisms **41***a*. Other portions of the light will disperse in different directions and is eventually affected by the microstructure layer and then emit from the surface of the light guide plate **40** corresponding to other light areas. In other words, the light guide plate **40** cannot limit the light generated by a particular light source **51** within a specified region and therefore the conventional side-lighting backlight module **10** cannot improve the contrast by selectively driving light sources **51**.

The conventional side-lighting backlight module **10** mentioned above can still use a V-shaped structure layer **41** and the microstructure layer corresponding to the light areas to achieve local dimming and improve the contrast of the displayed images. However, this design still cannot effectively eliminate the problem of light leakage to the adjacent light areas mentioned above.

SUMMARY OF THE INVENTION

It is an objective of the present invention to provide a local dimming side-lighting light guide plate and a local dimming side-lighting backlight module for the correspondingly display to selectively lighten different areas of the display.

It is another objective of the present invention to provide a local dimming side-lighting light guide plate and a local dimming side-lighting backlight module to increase the contrast of the corresponding display panel.

It is yet another objective of the present invention to provide a local dimming side-lighting light guide plate and a local dimming side-lighting backlight module to decrease the energy usage of the corresponding display panel.

The present invention relates to a local dimming side-lighting light guide plate and a local dimming side-lighting backlight module. The light guide plate of the present invention includes a light guide plate body and a plurality of first mediums, wherein the refractive index of the light guide plate body is greater than the refractive index of the first medium. The light guide plate body includes a plurality of gaps parallel with each other, wherein the first mediums are disposed in the gaps. The light guide plate body further includes a light entrance end, wherein the gaps extend in directions perpendicular to the light entrance end. Furthermore, an active region is defined on the light guide plate body and the gaps are located within the active region.

The light guide plate includes a plurality of light guide blocks and a plurality of connection blocks. The light guide blocks are arranged side by side and the gap is located between two adjacent light guide blocks. Two ends of the connection block are connected to two adjacent light guide blocks. Furthermore, the light guide block and the connection block can be made of materials of different refractive indexes. In addition, the width of the first medium corresponding to the top of the light guide plate body is greater than the width of the first medium corresponding to the bottom of the light guide plate body, wherein the first medium has a shape of triangle or trapezium.

In a different embodiment, the light guide plate further includes a second medium, wherein the first medium and the second medium are disposed in the same gap. The first medium and the second medium contact different portions of the light guide plate body and have different refractive indexes.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an exploded view of a conventional side-lighting backlight module;

FIG. **2** is an exploded view of the local dimming side-lighting backlight module of the present invention;

FIG. **3**A is a plane view of the light guide plate of the present invention;

FIG. **3**B is a plane view of a variation of the light guide plate illustrated in FIG. **3**A;

FIG. **3**C is a plane view of another variation of the light guide plate illustrated in FIG. **3**A;

FIG. **4** is a cross-sectional view of the light guide plate illustrated in FIG. **3**A;

FIG. **5** illustrates a variation of the light guide plate illustrated in FIG. **4**;

FIG. **6** is a cross-sectional view of another variation of the light guide plate;

FIG. **7** is a cross-sectional view of a variation of the light guide plate illustrated in FIG. **6**;

FIG. **8** is a plane view of another variation of the light guide plate illustrated in FIG. **6**;

FIGS. **9**A, **9**B, and **9**C are enlarged cross-sectional views of the light guide plate corresponding to the cross-section lines illustrated in FIG. **8**;

FIGS. **10**A, **10**B, **10**C are enlarged cross-sectional views of a variation of the light guide plate illustrated in FIGS. **9**A-**9**C;

FIG. **11** is a variation of the light guide plate illustrated in FIG. **8**;

FIGS. **12**A to **12**D are enlarged cross-sectional views corresponding to the cross-section lines illustrated in FIG. **11**; and

FIGS. **13**A to **13**D are enlarge cross-sectional views of a variation of the light guide plate illustrated in FIGS. **12**A to **12**D.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention relates to a side-lighting light guide plate and a side-lighting backlight module, specifically to a local dimming side-lighting light guide plate and a local dimming side-lighting backlight module.

FIG. **2** is an exploded view of the local dimming side-lighting backlight module **100** of the present invention. In the present embodiment, the backlight module **100** includes a first light source set **110**, a second light source set **120**, a diffusion film **130**, a reflector **140**, and a light guide plate **200**, wherein the first light source set **110** and the second light source set **120** are disposed at two opposite sides of the light guide plate **200**. Furthermore, the diffusion film **130** and the reflector **140** can be optionally included in the backlight module **100** to provide the desired optical effects.

Furthermore, the backlight module **100** preferably includes the diffusion film **130** disposed on one side of the light guide plate **200** opposite to the reflector **140**, wherein the diffusion film **130** processes the light emitted from the light guide plate **200** in order to compensate for the optical defects created by tolerances of the light guide plate **200** or environmental influence (such as particle pollution). In other words, the diffusion film **130** of the present embodiment is used to prevent frictions of the light guide plate and compensate for the optical defects created by tolerances of the light guide plate **200** and the environmental influences.

In the embodiment illustrated in FIG. **2**, the first light source set **110** and the second light source set **120** include a plurality of first light sources **111** and a plurality of second light sources **121** respectively, wherein the first light sources **111** and the second light sources **121** are light emitting diodes. Different portions of the light guide plate **200** can be defined as a plurality of light areas, wherein each of the light area is located between two adjacent gaps **220** and corresponds to different first light sources **111** or different second light sources **121**. In this way, the first light source **111** and the second light source **121** can be driven to provide the corresponding light area with the required luminance/light.

In the embodiment illustrated in FIG. **2**, the light guide plate **200** includes a light guide plate body **210** and a plurality of first mediums **400**. The light guide plate body **210** includes a plurality of gaps **220** for accommodating the first mediums **400** and light entrance ends **230**, wherein the first medium **400** can be air within the gaps **220**. Furthermore, the refractive index of the light guide plate body **210** is greater than the refractive index of the first medium **400**. In the present embodiment, the first light source set **110** and the second light source set **120** are disposed near two light entrance ends **230** opposite to each other and emit light toward the light guide body **210**, but are not limited thereto. In other preferred embodiments, the backlight module **100** of the present invention can also dispose the light sources near only one light entrance end **230**. In the embodiment illustrated in FIG. **2**, the first medium **400** fills the gap **220** and contacts the light guide plate body **210**. Therefore the first medium **400** will contact the light guide plate body **210** within the gap **220**. Furthermore, the first medium **400** of the present embodiment can be made of polymethylmethacrylate (PMMA), but is not limited thereto; in different embodiments, the first medium **400** can be air or made of other materials with refractive index greater than the refractive index of the light guide plate body **210**.

Here please refer to FIG. **3**A for the explanation of the working principle of the backlight module **100**. According to Snell's Law, when light travelling from an optically dense material (with larger refractive index n**1**) to a material with smaller refractive index n**2**, such as travelling from water to air, if the light incident angle θ_1 is equal to a critical angle θ_c, then the refracted light will travel alone the boundary between two materials, i.e. the refracted angle θ_2 is 90°.

If the incident angle θ_1 is greater than the critical angle θ_c and the sine of the incident angle $\sin\theta_1$ is greater n**2**/n**1** (i.e. $\sin\theta_1 > n2/n1$), then the sine of the refracted angle $\sin\theta_2$ is greater than 1 (i.e. $\sin\theta_2 > 1$). However, $\sin\theta_2 > 1$ does not exist and therefore light is not refracted but reflected back to the optically dense material. In other words, a total internal reflection of light occurs within the optically dense material. In addition, the critical angle is the smallest incident angle that the total internal reflection will occur and is dependent on the ratio of refractive index between two materials, i.e. $\theta_c = \arcsin(n2/n1)$. For instance, the refractive index of water is 1.33 and the refractive index of air is close to 1.00 and therefore the critical angle θ_c for light travelling from water to air is arcsin(1/1.33)=48.8°.

In the present embodiment, the refractive index of the light guide plate body **210** is greater than the refractive index of the first medium **400**, wherein the light guide plate body **210** is preferably made of materials with refractive index between 1.4 and 1.7. The first medium **400** is preferably made of materials with refractive index between 1.1 and 1.39. In this way, the critical angle θ_c for lights travelling within the light guide plate body **210** and making contact with the first medium **400** is arcsin(1.39/1.7)=54.80°. In other words, when the incident angle θ_1 of the first light L illustrated in FIG. **3**A is controlled to be greater than 54.80°, then the first light L will be reflected by the first medium **400**. At this moment, the first light L will not enter the first medium **400** and will travel within the light guide plate body **210** in a form of total internal reflection.

In this way, lights emitted by the first light source **111** and the second light source **121** will be limited within the corresponding portion of light guide plate body **210**. In other words, the backlight module **100** of the present invention can use the critical angle θ_c between the light guide plate body **210** and the first medium **400** as well as the incident angle θ_1 of lights making contact with the first medium **400** to achieve local dimming.

FIG. **3**A is a plane view of the light guide plate **200** of the present invention, wherein an active region **150** is defined on the light guide plate body **210**. In the present embodiment, the active region **150** defined on the light guide plate body **210** corresponds to an active area on a display panel (not illustrated), but is not limited thereto; in different embodiments, the area of the active region **150** can be greater than the above-mentioned active area. Furthermore, a microstructure layer (not illustrated) is disposed at the bottom of the light guide plate body **210** opposite to the active region **150**, wherein the microstructure layer is used to destroy the total reflection of the lights emitted by the first light sources **111** and the second light sources **121** so that those lights can eventually emit from one side of the light guide plate body **210** opposite to the microstructure layer. As FIG. **3**A shows, the gaps **220** on the light guide plate body **210** for accommodating the first mediums **400** are preferably located within the active region **150**, but are not limited thereto. In the embodiment illustrated in FIG. **3**B, the gaps **220** can also extend from the light entrance end **230** to the other light entrance end **230** on the opposite side of the light guide plate body **210**. In the present embodiment, a plurality of connection blocks (not illustrated) are defined at the bottom of the light guide plate body **210** corresponding to the gaps **220** and making contact with the first medium **400**. The connection block is used to connect portions of the light guide plate body **210** located at two opposite sides of the first medium **400** and also forms the gap **220** to accommodate the first medium **400**.

As FIG. **3**A shows, the first light source set **110** and the second light source set **120** are disposed near the light entrance ends **230**. In the present embodiment, the widths of first light source **111** and the second light source **121** are preferably smaller than the distance between two adjacent gaps **220**, but are not limited thereto; in different embodiments, the widths of the first light source **111** and the second light source **121** can be greater than the distance between two adjacent gaps **220**. The first light sources **111** or the second light sources **121** having width greater than the distance between adjacent gaps **220** can be spaced apart from each other and disposed near the light entrance end **230**.

FIG. **3**C is a plane view of a variation of the light guide plate **200** of the present invention. In the present embodiment, a second medium **450** is also disposed in the gap **220** on the light guide plate **200**, wherein the refractive index of the first medium **400** is smaller than the refractive index of the second medium **450**. The first medium **400** and the second medium **450** occupy different portions of one gap **220**. In other words, the first medium **400** and the second medium **450** contact different portions of the light guide plate body **210**.

In the embodiment illustrated in FIG. **3**C, the first medium **400** is disposed in the centre portion of the gap **220** while the second mediums **450** are disposed in the portions of the gap **220** near the first light source **111** and the second light source **121**. In this way, the incident angle of light contacting the first medium **400** is greater than the incident angle of light contacting the second medium **450**. Furthermore, the refractive index of the first medium **400** is smaller than the refractive index of the second medium **450** and therefore the critical angle between the light guide plate body **210** and the first medium **400** is smaller than the critical angle between the light guide plate body **210** and the second medium **450**. In this way, even if the incident angle of lights on the first medium **400** and the incident angle of lights on the second medium **450** are different, the light guide plate **200** can still use the difference in refractive index between the two mediums to limit the lights within the corresponding light area of the light guide plate body **210**.

For instance, in the embodiment illustrated in FIG. **3**C, the first light L and the second light M generated by the first light source **111** left the first light source **111** at different angles. The first light L makes contact with the first medium **400** at a first incident angle θ_A while the second light M makes contact with the second medium **450** at a second incident angle θ_B. In the embodiment illustrated in FIG. **3**C, the first incident angle θ_A is greater than the second incident angle θ_B. However, the critical angle between the light guide plate body **210** and the first medium **400** is smaller than the first incident angle θ_A. The critical angle between the light guide plate body **210** and the second medium **450** is smaller than the second incident angle θ_B. In this way, the first medium **400** and the second medium **450** can effectively reflect the first light L and the second light M back to the light guide plate body **210**.

FIG. **4** is a cross-sectional view of the light guide plate **200** illustrated in FIG. **3**A. As FIG. **4** shows, a plurality of light guide blocks **300** and a plurality of connection blocks **310** are defined in the light guide plate body **210**, wherein the light guide blocks **300** are arranged side by side and parallel with each other. On the other hand, two ends of the connection block **310** are connected to the adjacent light guide blocks **300**, so that a gap **220** is formed between the adjacent light guide blocks **300** and within the active region **150** as illustrated in FIG. **3**A to accommodate the first medium **400**.

As FIG. **4** shows, the connection block **310** is located below the first medium **400** and connected to the adjacent light guide blocks **300**. In other words, the first medium **400** is disposed in the gap **220** between adjacent light guide blocks **300** and above the connection block **310**. Therefore the light guide block **300**, the connection block **310**, and the first medium **400** can be regarded as a plurality of blocks of the light guide plate, wherein the light guide blocks **300** and the first mediums **400** are blocks arranged side by side and parallel with each other.

Furthermore, the light guide plate **200** includes a plurality of microstructure layers **500**, disposed at the bottom of the light guide plate body **210** to alter the paths of lights generated by the first light source **111** and the second light source **121**, so that those lights can emerge from one side of the light guide plate body **210** opposite to the microstructure layer **500**. In the present embodiment, the light guide plate **200** uses the microstructure layer **500** to alter the path of lights, but is not limited thereto; in different embodiments, the light guide plate **200** can use printed stripes, printed dots, raised bumps, raised dots, sunken stripes, sunken dots or a combination thereof to reflect or refract light. Furthermore, the dotted structure mentioned above can have shape of a circle, an oval or other figures.

In the embodiment illustrated in FIG. **4**, the light guide block **300** and the connection block **310** are preferably made of the same material. In other words, the light guide block **300** and the connection block **310** are preferably integrally formed as one piece. The light guide block **300** and the connection block **310** have the same refractive index and therefore a portion of lights emitted by the first light source **111** and the second light source **121** will pass through the connection block **310** and move toward adjacent light guide blocks **300**. At least a portion of lights will be broken by the microstructure layer **500** and emerge from one side of the light guide plate **200** opposite to the microstructure layer **500**. In this way, light emerging from the connection block **310** will smooth out the luminance of the corresponding area and prevent the occurrence of dark stripes from appearing on the location corresponding to the first medium **400**.

Furthermore, in the embodiment illustrated in FIG. **4**, the ratio of width between the first medium **400** and the connection block **310** is preferably 6:1, but is not limited thereto; in different embodiments, the ratio of width between the first medium **400** and the connection block **310** can be adjusted based on the amount of light needed to pass through the connection block **310**, the luminance of the light sources, and other factors. In this way, the light guide plate **200** of the present embodiment can control the luminance appearing on the location corresponding to the connection block **310** and prevent the occurrence of dark strips on the location corresponding to the first medium **400**. Furthermore, the design in the present embodiment allows some light to pass through the boundary between adjacent light guide blocks **300** to blur the boundary and prevent the boundary between adjacent light guide blocks **300** from becoming visible.

As mentioned above, in the embodiment illustrated in FIG. **4**, the light guide block **300** and the connection block **310** are made of the same material. However, in a variation embodiment illustrated in FIG. **5**, the light guide block **300** and the connection block **310** are made of different materials. Furthermore, the connection block **300** and the first medium **400** can be made of the same material. In this way, the connection block **310** and the first medium **400** can have the same refractive index and therefore the connection block **310** and the first medium **400** can reflect more lights generated by the first light source **111** and the second light source **121**. Lights can be limited within the light guide block **300** and travel in a form of total internal reflection. Furthermore, the light guide block **300**, the connection block **310**, and the first medium **400** can be made of materials with different refractive indexes. The refractive index of the light guide block **300** is preferably greater than the refractive indexes of the connection block **310** and the first medium **400**, wherein the refractive index of the connection block **310** is preferably greater than the refractive index of the first medium **400**, but is not limited thereto.

FIG. **6** is a cross-sectional view of the light guide plate **200** in another embodiment of the present invention. In the present embodiment, the width of the first medium **400** near the top of the light guide plate **200** is greater than the width of the first medium **400** near the bottom of the light guide plate **200** and the microstructure layer **500**. As FIG. **6** shows, two ends of the first medium **400** have different widths and therefore lights travelling in different directions will contact the first medium **400** at different incident angles. In this way, the incident angles of some lights will be smaller than the critical angle and those lights will pass through the top surface **201** of the light guide plate **200**. On the other hands, some lights will be reflected back to the light guide block **300** because their incident angles are smaller than the critical angle, wherein those lights will then be broken by the microstructure layer **500** and eventually emit from the top of the light guide plate **200**. In this way, those lights passing through the first medium **400** will harmonize the luminance on the area corresponding to the first medium **400** and prevent the occurrence of visible dark strip on the location of the first medium **400**.

FIG. **6** illustrates a schematic view of a first light L and a second light M projected on the cross-section of the light guide plate **200**, wherein the first light L and the second light M travel in a direction into the paper. As FIG. **6** shows, the first light L and the second light M travel in the light guide plate body **210** and contact the first medium **400** at different incident angles. In the present embodiment, the incident angle of the first light L when making contact with the first medium **400** is smaller than the critical angle between the light guide plate body **210** and the first medium **400**. Therefore the first light L will pass through the first medium **400** and travel toward the top of the light guide plate body **210**.

On the other hand, the incident angle of the second light M when making contact with the first medium **400** is greater than the critical angle between the light guide plate body **210** and the first medium **400**. Thus the second light M is reflected by the first medium **400** back to the light guide plate body **210**, broken by the microstructure layer **500**, and then emit from the top of the light guide plate body **210**.

FIG. **7** is a cross-sectional view of a variation embodiment of the light guide plate **200** illustrated in FIG. **6**. In the present embodiment, the first medium **400** is preferably a trapezoidal prism. In other words, the first medium **400** disposed in the gap **220** preferably has a trapezoidal side. In the present embodiment, the microstructure layer **500** is disposed on the bottom of the light guide plate body **210**, wherein an interval **221** exists between adjacent microstructure layers **500**. As FIG. **7** shows, the location of the interval **221** corresponds to the bottom of the first medium **400**. In other words, the microstructure layer **500** is not disposed at the bottom of the first medium **400**, but is not limited thereto. In different embodiments, the microstructure layer **500** can be optionally disposed at a portion of the bottom of the first medium **400**.

Furthermore, in the embodiments illustrated in FIG. **6** and FIG. **7**, the first medium **400** can be a triangular prism or a trapezoidal prism, but is not limited thereto; in different embodiments, the first medium **400** of the present invention can also be an oval prism, a circular prism, or other prisms with suitable shapes.

FIG. **8** is a plane view of a variation of the light guide plate **200** illustrated in FIG. **6**, wherein the first light sources **111** are disposed at only one light entrance end **230** near the light guide plate body **210**. As FIG. **8** shows, the first medium **400** extends along an extending direction **600** toward and away from the light entrance end **230**. Furthermore, in the present embodiment, portions of the first medium **400** distributed along the extending direction **600** have different thickness (here please also refer to FIGS. **9**A, FIG. **9**B, and FIG. **9**C).

FIGS. **9**A, **9**B, and **9**C are cross-sectional views corresponding to cross-section lines A, B, and C in FIG. **8**. In the present embodiment, the thickness of the first medium **400** increases along the extending direction **600** toward the light entrance end **230**. As FIGS. **9**A, **9**B, and **9**C show, the thickness of the portion of the first medium **400** near the light entrance end **230** is greater than the thickness of the portion of the first medium **400** distant from the light entrance end **230**. Furthermore, the incident angle smaller than the critical angle makes it easier for the first light L emitted by the first light source **111** to pass through the first medium **400** near the light entrance end **230** and eventually emit from the top surface of the light guide plate **200**. In this way, the thicker portion of the first medium **400** near the light entrance end **230** can reflect more lights back to the light guide plate body **210**. On the other hand, the incident angle greater than the critical angle makes it easier for the second light M generated by the first light source **111** to be reflected by the portion of the first medium **400** distant from the light entrance end **230** back to the light guide plate body **210**. Therefore the thinner portion of the first medium **400** distant from the light entrance end **230** allows more lights to be broken by the microstructure layer **500** and emit from the top surface of the light guide plate body **210**. In this way, the luminance of the light guide plate **200** is harmonized. In other words, the first medium **400** having increasing thickness can be used to harmonize the luminance of the backlight module **100** corresponding to the location of the first medium **400**.

Furthermore, in the embodiment illustrated in FIGS. **9**A, **9**B, and **9**C, the width of the first medium **400** corresponding to the top surface of the light guide plate **200** is substantially the same, but is not limited thereto. FIGS. **10**A, **10**B, and **10**C illustrate a variation of the light guide plate **200** illustrated in FIGS. **9**A to **9**C, wherein the width of the first medium **400** corresponding to the top surface of the light guide plate **200** also increases along the extending direction **600** toward the light entrance end **230**.

FIG. **11** illustrates a variation of the light guide plate **200** illustrated in FIG. **8**. The light guide plate **200** of the present embodiment further includes a second medium **450** which is also disposed in the gap **220**, wherein the second medium **450** is closer to the light entrance end **230** and the first light sources **111** than the first medium. In the embodiment illustrated in FIG. **11**, the first medium **400** and the second medium **450** have the same extending direction **600**. Furthermore, FIGS. **12**A to **12**D are the enlarged cross-sectional views corresponding to the cross-section lines A, B, C, and D illustrated in FIG. **10**.

Here please refer to FIGS. **11** and FIGS. **12**A to **12**D. The thicknesses of the first medium **400** and the second medium **450** increases along the extending direction **600** toward the light entrance end **230**. In the present embodiment, the thickness of the first medium **400** increases from one end of the extending direction **600** that is distant from the light entrance **230** toward the light entrance **230**. On the other hand, the thickness of the second medium **450** increases from the connection between the first medium **400** and the second medium **450** toward the light entrance end **230**. This shows that the width of every portion of the second medium **450** is greater than the first medium **400**.

As mentioned above, the thickness of the second medium **450** is greater than the thickness of the first medium **400**. Furthermore, the refractive index of the first medium **400** is smaller than the refractive index of the second medium **450**. Therefore, the critical angle between the light guide plate body **210** and the first medium **450** is smaller than the critical angle between the light guide plate body **210** and the second medium **400**. However, the incident angle of the first light L is smaller than the corresponding critical angle and therefore it is easier for the first light L emitted by the first light source **111** to pass through the second medium **450** near the light entrance end **230** and then emit from the top surface of the light guide plate **200**. Thus the thicker second medium **450** near the light entrance end **230** allows more light to exit from the top surface of the light guide plate **200**.

On the other hand, the incident angle of the second light M is greater than the corresponding critical angle and therefore it is easier for the second light M emitted by the first light source **111** to be reflected back to the light guide plate body **210** by the first medium **400** distant from the light entrance end **230**. Therefore the amount of light passing through the thinner first medium **400** distant from the light entrance end **230** and reflected by the first medium **400** is substantially the same as the amount of light passing through the second medium **450** and reflected by the second medium **450**. In this way, the luminance of the light guide plate **200** near the first medium **400** and the second medium **450** are harmonized. In other words, the increase in thicknesses of the first medium **400** and the second medium **450** in the direction toward the light entrance end **230** can be used to harmonize the luminance of the backlight module **100** corresponding at the locations of the first medium **400** and the second medium **450**.

In the embodiment illustrated in FIGS. **12**A to **12**D, the widths of the first medium **400** and the second medium **450** corresponding to the top surface of the light guide plate **200** are substantially equal, but are not limited thereto. FIGS. **13**A to **13**D illustrate a variation of the light guide plate **200** illustrated in FIGS. **12**A to **12**D, wherein the widths of the first medium **400** and the second medium **450** corresponding to the top surface of the light guide plate **200** increase along an extending direction **600** toward the light entrance end **230**.

In the embodiments illustrated in FIGS. **8** to **13**D, the first medium **400** and the second medium **450** are selected from triangular prisms, but are not limited thereto; in different embodiments, the first medium **400** and the second medium **450** can be selected from rectangular prisms, trapezoidal prisms, oval prisms, circular prisms, or other prisms with suitable shapes.

The above is detailed descriptions of the particular embodiments of the invention which is not intended to limit the invention to the embodiments described. It is recognized that modifications within the scope of the invention will occur to a person skilled in the art. Such modifications and equivalents of the invention are intended for inclusion within the scope of this invention.

What is claimed is:

1. A light guide plate, comprising:

a light guide plate body, including a continuous light entrance end and a plurality of gaps extending perpendicular to the light entrance end and substantially parallel to one another, opposite ends of each gap defined at a distance from a corresponding edge of the light guide plate body along an extending direction of the gaps; and

a plurality of first mediums disposed in the gaps, wherein a refractive index of the light guide plate body is greater than a refractive index of the first medium; a thickness of the first mediums increases along an extending direction of the first medium toward the light entrance end.

2. A display system including light guide plate of claim **1**, further comprising:

a display panel having an active area;

wherein the light guide plate body has an active region with a size corresponding to the active area and the gaps are located within the active region.

3. The light guide plate of claim **1**, further including a plurality of microstructure layers disposed on a bottom of the light guide plate body, wherein an interval exists between two adjacent microstructure layers and corresponds to the gap.

4. A backlight module, comprising:

the light guide plate of claim **1**; and

a plurality of light emitting elements, wherein each of the light emitting elements is disposed at a position of the light guide plate corresponding to the light entrance end and emits a light into the light guide plate body from the light entrance end.

5. The light guide plate of claim **1**, further including a plurality of second mediums disposed in the gaps, wherein the first medium and the second medium disposed in the same gap contact different portions of the light guide plate body, the refractive index of the first medium is smaller than a refractive index of the second medium.

6. The light guide plate of claim **5**, wherein the first medium and the second medium have same extending direction, a thickness of the first medium and a thickness of the second medium increase along the extending direction toward the light entrance end.

7. The light guide plate of claim **1**, wherein the light guide plate body includes a top and a bottom, wherein a thickness of the first medium near the top of the light guide plate body is greater than the thickness of the first medium near the bottom of the light guide plate body.

8. The light guide plate of claim **7**, wherein a shape of the first medium includes a triangular prism or a trapezoidal prism.

9. The light guide plate of claim **1**, wherein the light guide plate body includes:

a plurality of light guide blocks arranged side by side, wherein the gap is located between two adjacent light guide blocks; and

a plurality of connection blocks, wherein two ends of the connection block connect to two adjacent light guide blocks.

10. The light guide plate of claim **9**, wherein the first mediums are in the gaps along a surface of the connection block.

11. The light guide plate of claim **9**, wherein the first medium is disposed on the connection block.

12. The light guide plate of claim **11**, wherein the light guide block and the connection block are made of the same material.

13. The light guide plate of claim **11**, wherein the light guide block and the connection block are made of materials with different refractive indexes.

14. A light guide plate, comprising:

a top;

a bottom;

a plurality of light guide blocks arranged side by side and substantially parallel to each other, wherein adjacent light guide blocks are at least partially connected, each of the light guide blocks includes a light entrance end; and

a plurality of first mediums disposed between the adjacent light guide blocks, wherein a refractive index of the light guide block is greater than a refractive index of the first medium, a thickness of the first medium near the top is greater than the thickness of the first medium near the bottom.

15. The light guide plate of claim **14**, wherein a shape of the first medium includes a triangular prism or a trapezoidal prism.

16. The light guide plate of claim **14**, wherein a thickness of the first medium increases along an extending direction toward the light entrance end.

17. The light guide plate of claim **14**, further including a plurality of microstructure layers disposed on a bottom of the light guide block, wherein an interval exists between two adjacent light guide blocks and corresponds to the first medium.

18. A backlight module, comprising:

the light guide plate of claim **14**; and

a plurality of light emitting elements, wherein each of the light emitting elements is disposed at a position corresponding to the light entrance end of one of the light guide blocks and emits a light into the light guide block from the light entrance end.

19. The light guide plate of claim **14**, further including a plurality of second mediums disposed between two adjacent light guide blocks, wherein the first medium and the second medium between two adjacent light guide blocks contact different portions of the light guide blocks, the refractive index of the first medium is smaller than a refractive index of the second medium.

20. The light guide plate of claim **19**, wherein the first medium and the second medium have same extending direction, a thickness of the first medium and a thickness of the second medium increase along the extending direction toward the light entrance end.

21. The light guide plate of claim **14**, further including a plurality of connection blocks, wherein two opposite ends of the connection block respectively connect to two adjacent light guide blocks to form at least one gap between the adjacent light guide blocks, the gap extends perpendicular to the light entrance end, the first medium is located in the gap.

22. A display system including light guide plate of claim **21**, further comprising:

a display panel having an active area;

wherein the light guide plate has an active region with a size corresponding to the active area and the gap is located within the active region.

23. The display system of claim **22**, wherein a portion of the connection block is located outside the active region.

24. The light guide plate of claim **21**, wherein the first medium is disposed in the gap along a surface of the connection block.

25. The light guide plate of claim **21**, wherein the first medium is stacked on the connection block.

26. The light guide plate of claim **25**, wherein the light guide block and the connection block are made of the same material.

27. The light guide plate of claim **25**, wherein the light guide block and the connection block are made of materials with different refractive index.

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